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ABSTRACT

This document, which is intended to serve as a guide for work force preparation program providers, details the Illinois occupational skill standards for programs preparing students for employment in jobs in the heating, ventilation, air conditioning, and refrigeration (HVAC/R) industry. Agency partners involved in this project include: the Illinois State Board of Education, Illinois Community College Board, Illinois Board of Higher Education, Illinois Department of Commerce and Community Affairs, and the Illinois Department of Employment Security. The document begins with a brief overview of the Illinois perspective on occupational skill standards and credentialing, the process used to develop the skill standards, and assumptions underlying the standards. Presented next are skill standards for 75 tasks typically performed by HVAC/R technicians. Each skill standard statement contains the following components: (1) the actual skill standard (including the conditions of performance, work to be performed, and

performance criteria); (2) performance elements; and (3) performance assessment criteria. The tasks for which skill standards are provided are organized into the following categories: (1) accident and emergency procedures; (2) evaluation and replacement of air conditioning units, heat pumps, and refrigeration; and (3) evaluation and inspection of furnaces and air handlers. Appended are the following: list of contents of the HVAC/R technician tool kit; glossary; lists of Transportation, Distribution, and Logistics Subcouncil and HVAC/R Technician Cluster Standards Development Committee members; and list of necessary workplace skills. (MN)

ILLINOIS

OCCUPATIONAL SKILL STANDARDS

HVAC/R TECHNICIAN CLUSTER

ILLINOIS OCCUPATIONAL SKILL STANDARDS
HVAC/R TECHNICIAN CLUSTER

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Illinois Department of Employment Security

ILLINOIS OCCUPATIONAL SKILL STANDARDS

HVAC/R TECHNICIAN CLUSTER

Endorsed for Illinois
by the
Illinois Occupational Skill Standards
and Credentialing Council

A MESSAGE FROM THE ILLINOIS OCCUPATIONAL SKILL STANDARDS AND CREDENTIALING COUNCIL

Preparing youth and adults to enter the workforce and to be able to contribute to society throughout their lives is critical to the economy of Illinois. Public and private interest in establishing national and state systems of industry-driven skill standards and credentials is growing in the United States, especially for occupations that require less than a four-year college degree. This interest stems from the understanding that the United States will increasingly compete internationally and the need to increase the skills and productivity of the front-line workforce. The major purpose of skill standards is to promote education and training investment and ensure that this education and training enables students and workers to meet industry standards that are benchmarked to our major international competitors.

The Illinois Occupational Skill Standards and Credentialing Council (IOSSCC) has been working with industry subcouncils, the Illinois State Board of Education and other partnering agencies to adopt, adapt and/or develop skill standards for high-demand occupations. Skill standards products are being developed for a myriad of industries, occupational clusters and occupations. This document represents the collaborative effort of the Transportation, Distribution and Logistics Subcouncil, and the Heating, Ventilation, Air Conditioning and Refrigeration (HVAC/R) Cluster Standards Development Committee.

These skill standards will serve as a guide to workforce preparation program providers in defining content for their programs and to employers to establish the skills and standards necessary for job acquisition. These standards will also serve as a mechanism for communication among education, business, industry and labor.

We encourage you to review these standards and share your comments. This effort has involved a great many people from business, industry and labor. Comments regarding their usefulness in curriculum and assessment design, as well as your needs for in-service and technical assistance in their implementation are critical to our efforts to move forward and improve the documents.

Questions concerning this document may be directed to:

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We look forward to your comments.

Sincerely,

The Members of the IOSSCC

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THE ILLINOIS PERSPECTIVE

The Occupational Skill Standards Act (PA 87-1210) established the nine-member Illinois Occupational Skill Standards and Credentialing Council (IOSSCC). Members of the IOSSCC represent business, industry and labor and are appointed by the Governor or State Superintendent of Education. The IOSSCC, working with the Illinois State Board of Education, Illinois Community College Board, Illinois Board of Higher Education, Illinois Department of Employment Security and Illinois Department of Commerce and Community Affairs, has created a common vision for workforce development in Illinois.

VISION

It is the vision of the IOSSCC to add value to Illinois' education and workforce development system by developing and supporting the implementation of a statewide system of industry defined and recognized skill standards and credentials for all major skilled occupations that provide strong employment and earnings opportunities.

The IOSSCC endorses occupational skill standards and credentialing systems for occupations that

- require basic workplace skills and technical training,
- provide a large number of jobs with either moderate or high earnings, and
- provide career advancement opportunities to related occupations with moderate or high earnings.

Subcouncils and Standards Development Committees

Under the direction of the IOSSCC, and in cooperation with industry organizations and associations, industry subcouncils have been formed to review, approve and promote occupational skill standards and credentialing systems. The industry subcouncils are: Agriculture and Natural Resources; Applied Science and Engineering;* Business and Administrative Information Services; Communications; Construction;* Education and Training Services;* Energy and Utilities;* Financial Services; Health and Social Services; Hospitality; Legal and Protective Services;* Manufacturing; Marketing and Retail Trade; and Transportation, Distribution and Logistics. (*Indicates subcouncils identified for future development.)

Standards development committees are composed of business, labor and education representatives who are experts in the related occupational cluster. They work with the product developer to

- develop or validate occupational skill standards,
- identify related academic skills,
- develop or review assessment or credentialing approaches, and
- recommend endorsement of the standards and credentialing system to the industry subcouncil.

Expected Benefits

The intent of skill standards and credentialing systems is to promote investment in education and training and ensure that students and workers are trained to meet industry standards that are benchmarked to the state's major international competitors. Skill standards and credentialing systems have major benefits that impact students and workers, employers and educators in Illinois.

Student and Worker Benefits

- Help workers make better decisions about the training they need to advance their careers
- Allow workers to communicate more effectively to employers what they know and can do
- Improve long-term employability by helping workers move more easily among work roles
- Enable workers to help their children make effective academic and career and technical decisions

Employer Benefits

- Focus the investment in training and reduce training costs
- Boost quality and productivity and create a more flexible workforce
- Improve employee retention
- Improve supplier performance
- Enlarge the pool of skilled workers

Educator Benefits

- Keep abreast of a rapidly changing workplace
- Contribute to curriculum and program development
- Provide students with better career advice
- Strengthen the relationship between schools and local businesses
- Communicate with parents because educators have up-to-date information about industry needs

The IOSSCC is currently working with the Illinois State Board of Education and other state agencies to integrate the occupational standards with the Illinois Learning Standards which describe what students should know and be able to do as a result of their education. The IOSSCC is also working to integrate workplace skills—problem solving, critical thinking, teamwork, etc.—with both the Illinois Learning Standards and the Illinois Occupational Skill Standards.

IOSSCC Requirements for Occupational Skill Standards

Illinois Occupational Skill Standards define what an individual should know and the expected level of performance required in an occupational setting. They focus on the most critical work performances for an occupation or occupational area.

Any occupational skill standards and credentialing system seeking IOSSCC endorsement must

- represent an occupation or occupational cluster that meets the criteria for IOSSCC endorsement, including economic development, earnings potential and job outlook;
- address both content and performance standards for critical work functions and activities for an occupation or occupational area;
- ensure formal validation and endorsement by a representative group of employers and workers within an industry;
- provide for review, modification and revalidation by an industry group a minimum of once every five years;
- award credentials based on assessment approaches that are supported and endorsed by the industry and consistent with nationally recognized guidelines for validity and reliability;
- provide widespread access and information to the general public in Illinois; and
- include marketing and promotion by the industry in cooperation with the partner state agencies.

Occupations that do not meet the earnings criteria for IOSSCC endorsement, but are part of an occupational cluster that is being developed, may be presented for recognition by the IOSSCC. IOSSCC members encourage individuals to pursue occupational opportunities identified as endorsed occupations. Examples of occupations that do not meet the endorsement criteria, but have been recognized by the IOSSCC are Certified Nurse Assistant and Physical Therapy Aide.

Skill Standards Components

Illinois Occupational Skill Standards must contain these areas:

- Performance Area
- Performance Skill
- Skill Standard
- Performance Elements
- Performance Assessment Criteria

The Council further identified three components of the Skill Standard (*Conditions of Performance, Work to be Performed and Performance Criteria)* as critical work functions for an occupation or industry/occupational area. The sample format for Illinois Occupational Skill Standards on the following page provides a description of each component of a skill standard.

The sample format also illustrates the coding at the top of each page identifying the state, fiscal year in which standards were endorsed, Subcouncil abbreviation, cluster abbreviation and standard number. For example, the twenty-fifth skill standard in the HVAC/R Technician Cluster, which has been developed by the Transportation, Distribution and Logistics Subcouncil, would carry the following coding: IL.01.TRANS.HVAC/R.25.

SUMMARY OF WORK TO BE PERFORMED. SUMMARY IS BRIEF AND BEGINS WITH AN ACTION VERB.

IL.FY.SUBCOUNCIL. CLUSTER. STANDARD NO.

PERFORMANCE AREA

SKILL STANDARD

CONDITIONS OF PERFORMANCE

A comprehensive listing of the information, tools, equipment and other resources provided to the person(s) performing the work.

WORK TO BE PERFORMED

An overview of the work to be performed in demonstrating the performance skill standard. This overview should address the major components of the performance. The detailed elements or steps of the performance are listed under "Performance Elements."

PERFORMANCE CRITERIA

The assessment criteria used to evaluate whether the performance meets the standard. Performance criteria specify product/outcome characteristics (e.g., accuracy levels, appearance, results, etc.) and process or procedure requirements (e.g., safety requirements, time requirements, etc.).

PERFORMANCE ELEMENTS

Description of the major elements or steps of the overall performance and any special assessment criteria associated with each element.

PERFORMANCE ASSESSMENT CRITERIA

Listing of required testing, certification and/or licensing.

Product and process used to evaluate the performance of the standard.

PRODUCT

Description of the product resulting from the performance of the skill standard.

PROCESS

Listing of steps from the Performance Elements which must be performed or the required order or performance for meeting the standard.

OCCUPATIONAL EARNINGS AND EMPLOYMENT INFORMATION FOR HVAC/R TECHNICIAN CLUSTER SKILL STANDARDS

I. Developmental Process and Occupational Definition

A. Developmental Process

After studying labor market information, industry leaders recommended that performance skill standards be developed for Heating, Ventilation, Air Conditioning and Refrigeration (HVAC/R) occupations. The HVAC/R Technician Cluster meets the criteria established by the Illinois Occupational Skill Standards and Credentialing Council (IOSSCC) for performance skill standard development, education and training requirements, employment opportunities, earnings potential and career opportunities. The careers identified in the HVAC/R Technician Cluster include air conditioning technician, furnace and air handler technician, heat pump technician and refrigeration technician. A product developer knowledgeable about the HVAC/R field began the process of performance skill identification. The product developer prepared an outline and framework designed to address the major skills expected in the workplace. The framework addresses skill requirements common in the field.

The Transportation, Distribution and Logistics Subcouncil recommended the final skill standards product be presented to the IOSSCC. The IOSSCC reviewed the skill standards and met with the product developer and state liaison. Based on the review, the IOSSCC voted to endorse the HVAC/R Technician Cluster skill standards.

1. Resources

The HVAC/R standards were based on descriptions and competencies identified through researching the career area. Information from the Air Conditioning Contractors of America (ACCA), Air Conditioning & Refrigeration Institute (ARI) and Refrigeration Service Engineers Society (RSES) was incorporated into this product.

2. Standards Development Committee

A standards development committee composed of individuals who work in the HVAC/R industry was convened. The framework, initial outline, matrix and draft skill standards were presented to the standards development committee for review, revision, adjustment and validation. At the final meeting, educators joined the standards development committee to review the skill standards for consistency in terminology and the assessment criteria for content.

B. Occupational Definitions

The function of the HVAC/R technician is to install and maintain equipment designed to provide clean air, comfortable conditions and safe and healthy environments in a variety of settings. These settings include structures from single family dwellings to large private and public buildings of all types. The matrix categorizes the skills and technicians (i.e., Air Conditioning Technician, Refrigeration Technician, Furnace and

Air Handler Technician and Heat Pump Technician) by the type of work required which is determined by the particular piece of equipment being serviced. Most HVAC/R technicians are trained and qualified to work on all types of equipment. Therefore, the definitions for the above named matrix categories are encompassed in one definition of the HVAC/R Technician.

HVAC/R Technician

HVAC/R technicians evaluate, install, repair and replace components on electrical and gas fired furnaces, air handlers and refrigeration systems. This requires the ability to read and understand blueprints, schematics and electrical wiring diagrams and test electrical components. In addition, these duties require mechanical and welding ability. Technicians who handle refrigerant must have an Environmental Protection Agency (EPA) Refrigerant Handling Certification.

II. Employment and Earnings Opportunities

A. Education and Training Requirements

HVAC/R Technician Cluster occupations require basic workplace skills and training according to industry/organization standards. Requirements will also vary depending on the employer.

A strong career ladder exists between entry-level HVAC/R positions and the manager/supervisor of operations. Many contractors require their manager/supervisor to have five or more years of field experience in order to be able to assist the technician if necessary.

Instructional programs prepare individuals to apply technical knowledge and skills to repair, install, service and maintain the operating condition of heating, air conditioning and refrigeration systems. This includes instruction in diagnostic techniques, the use of testing equipment and the principles of mechanics, electricity and electronics as they relate to the repair of heating, air conditioning and refrigeration systems. These programs may be offered through participation in tech prep programs, union apprenticeships, community colleges, vocational schools and informal on-the-job training.

In union shops, almost all trainees are trained through either the plumbers and pipefitters or sheet metal four-year apprenticeship programs. A high school diploma or GED is required for entrance into these programs. Applicants must pass a written exam with a score of 70 or higher and participate in an oral interview. A combined score of the exam and the oral interview is assigned to the individual who is placed on a waiting list for the apprenticeship program. Once an individual is on the waiting list, he or she is normally accepted into an apprenticeship program within a few months.

In nonunion shops, most trainees begin as helpers and learn skills informally on the job. For these training positions, a high school diploma is preferred. Courses in math, science, shop and mechanical drawing are required.

Tech prep programs consist of academic and technical courses taught during the last two years of high school and, at a minimum, two years of postsecondary education leading to an Associate of Applied Science degree or completion of an adult apprenticeship. Some programs may also lead to four-year baccalaureate degrees. Instruction in academic, technical and workplace skills are delivered both at the work site and in the school/college setting.

Community colleges and vocational schools offer a certificate of completion once the program in a particular field of study is accomplished.

Technicians who handle refrigerant are required to have Environmental Protection Agency (EPA) Refrigerant Handling Certification.

B. Employment Opportunities

In Illinois it is projected that by the year 2008 employment in this occupation will grow by 20%, an increase of 2,000 positions. Each year, almost 400 positions will become open due to both the aforementioned growth and to job replacement needs.

Experienced heating and cooling system technicians may advance to positions such as supervisor. Others may be promoted to estimators or manufacturers' service specialists. Some technicians may become city or county inspectors and some establish their own repair shop or contracting business.

C. Earnings Opportunities

	Middle Range Annual Earnings, 1999*
Heating, Air Conditioning & Refrigeration Technicians & Installers	$21,750 – $45,225

Middle Range is the middle 50%; i.e. one-fourth of persons in the occupation earn below the bottom of the range and one-fourth of persons in the occupation earn above the top of the range.

Sources: *2000 Occupational Employment Statistics: Wage Data and Occupational Projections 2008*, Illinois Department of Employment Security, Economic Information and Analysis Division; *Horizons Career Information System; Encyclopedia of Careers & Vocational Guidance-10th Edition*.

III. Assessment and Credentialing Systems

The IOSSCC recognizes that industry commitment for third-party assessment is beneficial and requests that each standards development committee and/or subcouncil identify the most beneficial method for assessing the standards.

IV. Industry Support and Commitment

The primary areas currently identified for industry support and commitment of occupational skill standards are development, updating and marketing. Business and industry partners may identify future uses of occupational skill standards such as credentialing/certification, career development of employees and specifications for out-source training programs.

A. Industry Commitment for Development and Updating

1. The development of skill standards for the HVAC/R Technician Cluster is the direct result of efforts by industry leaders and the standards development committee. Names of the persons serving on the subcouncil and the standards development committee are located in the appendices.

2. In developing the products, the following steps were completed:

   a. Identification and prioritization of career ladder, identifying jobs by name
   b. Review of resources
   c. Development of draft matrix of performance standards
   d. Development of performance standard that was identified on matrix
   e. Convening of standards development committee of incumbent workers
   f. Review, validation and approval of skill standards by standards development committee
   g. Review and approval of standards by subcouncil
   h. Endorsement of skill standards by IOSSCC

3. Industry leaders support a regular review and revision process to ensure the standards reflect the rapidly changing industry.

B. Industry Commitment for Marketing

Industry leaders are committed to marketing and obtaining support and endorsement from the leading industry associations impacted by the skill standards. Upon recognition/endorsement of the standards by the IOSSCC, the industry leaders strongly recommend that professional trade groups, academic groups, etc. develop and provide an in-service/seminar package to promote skill standard awareness and to obtain full industry support and commitment for the development of a full industry marketing plan.

ASSUMPTIONS FOR HVAC/R TECHNICIAN CLUSTER SKILL STANDARDS

Skill standards assume that individuals have received education and/or training in a setting such as a secondary, postsecondary and/or apprenticeship/on-the-job training program and have the background knowledge necessary for performing the skill standards contained in this publication. The education and/or training includes instruction for the proper handling and operation of materials, tools and equipment required for performing the skills including the purpose of use, when to use, how to use and any related safety issues.

The instructional/training program must adhere to all local, state and federal licensing and/or certification requirements as set by law, if applicable.

The Standards Development Committee developed these skill standards based on the following assumptions:

1. Workplace skills (employability skills) are expected of the individual. Socialization skills needed for work are related to lifelong career experience and are not solely a part of the initial schooling process. These are not included with this set of statements.
2. Specific policies and procedures of the work site will be made known to the individual and will be followed.
3. Time elements outlined for the skill standards result from the experience and consideration of the panel of experts who made up the standards development committee.
4. Skill standards describe the skill only and do not detail the background knowledge or theory related to the particular skill base. Although the skill standard enumerates steps to successful demonstration, rote approaches to the outcomes are not prescribed.
5. The time it takes to complete some standards will vary depending on the complexity of the equipment construction as well as the location of the component within the equipment.
6. Skills will be completed in an expedient and safe manner.
7. Skill standards are selected because they meet workplace needs and are designed to meet professional standards of practice.
8. Skill standards do not replace, supersede or substitute for procedure manuals.
9. Skill standards do not supersede or take the place of industry certification or graduation from an accredited program of study.
10. The HVAC/R technician is knowledgeable in the following areas:
    a. General testing
        1) Proper reading and interpreting of a schematic or wiring diagram
        2) Proper use of ammeter
        3) Proper use of capacitor tester
        4) Proper use of manometer
        5) Proper use of multimeter
        6) Proper use of ohmmeter
        7) Proper use of voltmeter
        8) Isolation of item when checking for continuity
        9) Meter setting for proper function and range for item being tested if not autoranging
    b. Refrigerant testing
        1) Proper use of refrigerant leak detector
        2) Proper use of manifold gauge and hose set

3) Proper use of EPA certified refrigerant recovery machine and DOT certified recovery tanks
4) Proper use of refrigerant scale
5) Proper use of charging cylinder if required
6) Proper handling and storage of refrigerant cylinders
7) Importance of not mixing refrigerants
8) Proper charging of refrigerant being used
9) Proper use of vacuum pump to evacuate refrigerant system
10) Proper use of micron gauge

c. Other items including hazardous materials
1) Wearing of appropriate safety apparel such as hard hat, shoes, eye protection, hearing protection, dust protection, etc.
2) Wearing of appropriate and safe clothing
3) Understanding of what constitutes hazardous materials
4) Identifying and labeling hazardous materials
5) Handling and storage of hazardous materials
6) Proper disposal of hazardous materials in accordance with EPA requirements
7) Proper interpretation of Material Safety Data Sheets (MSDSs)
8) Keeping of copies of all necessary MSDSs for reference should need arise
9) Proper and safe method of using tools of trade
10) Proper handling and storage of gases used for brazing, soldering and testing procedures
11) Proper selection of either soldering or brazing materials
12) Proper procedure for soldering and brazing including flow of inert gas through system when brazing

11. Thorough diagnostics have been performed and a decision has been made where fault is in the system. Individual skills refer to repair and/or replacement procedures. The following are proper diagnostic assumptions and procedures that should be followed in making appropriate conclusions:
a. Refrigerant leak testing
1) Technician understands danger involved and uses caution and proper safety protection. Improper testing procedures could be fatal.
2) Environmental Protection Agency (EPA) Refrigerant Handling Certification is required for all refrigerant related operations.
3) Technician knows and understands operation of specific type of leak detector being used.
4) Common condition in refrigerant leak is oil film around leak. Technician should not assume that leak exists at that location. It is possible that leak does exist at oil film location; film is still present from previous leak; or leak will not have oil film present.
5) When checking system that is void of refrigerant, it may be necessary to add some refrigerant to system, depending on type of leak detector being used. In this situation, or when the system pressure is too low for checking, dry nitrogen is used to mix with refrigerant to increase pressure. EPA regulations should be followed.
6) Regardless of type of leak detector being used, technician must be patient. When using ultraviolet leak detector, technician should make sure system has been operated for time period recommended by manufacturer after fluorescent solution has been added to system.
7) Some leaks are easier to locate with system off, while others may be easier to locate with system operating (e.g., leak in low side of system). When system is off, pressure is higher in low side of system than when operating (e.g., leak in high side of system). When system is operating, pressure is higher in high side of system than when system is off.

b. Electrical testing
   1) Caution should always be used to prevent the possibility of an electrical shock. Lack of caution when working around high voltage could be fatal.
   2) Technician understands danger involved and proceeds with caution in proper use of test equipment.
   3) Technician understands that some electrical components must be tested with power applied to component as determined by required test being performed.
   4) Ammeter must be set to proper range when checking current draw to device. Multiplier may be required depending on circuit being tested.
   5) Power must be off when using ohmmeter. The meter could be damaged if power is on. Wires going to coil, contacts, windings, etc. that are being tested must be removed from one side of coil, contacts, windings, etc. Failure to do this could result in false reading.
   6) Voltmeter must be set to proper voltage range to prevent damage to meter. Test leads must contact only terminals being tested. Care should be exercised to prevent a short by not allowing test leads to make contact with adjacent terminals or case.

PERFORMANCE SKILL LEVELS

	Air Conditioning Technician	Furnace and Air Handler Technician	Heat Pump Technician	Refrigeration Technician
ACCIDENT AND EMERGENCY PROCEDURES				
Follow Accident/Incident Response Procedures	•	•	•	•
AIR CONDITIONING/HEAT PUMPS/REFRIGERATION				
Replace Schrader Valve Core	•		•	•
Evaluate Lockout Relay and Replace	•		•	•
Evaluate Contactor and Replace	•		•	•
Evaluate Run or Start Capacitor and Replace	•	•	•	•
Evaluate Compressor Potential Start Relay and Replace	•		•	•
Evaluate Compressor Current Start Relay and Replace				•
Replace Condenser Fan Blade	•		•	•
Evaluate Blower or Fan Motor and Replace	•	•	•	•
Evaluate Service Valve and Replace	•		•	•
Evaluate High Pressure Switch and Replace	•		•	•
Evaluate Low Pressure Switch and Replace	•		•	•
Evaluate Low Pressure Switch for Temperature Control and Replace				•
Evaluate Thermostat Temperature Control and Replace	•	•	•	•
Evaluate Liquid Line Drier and Replace	•		•	•
Evaluate Suction Line Filter and Replace	•		•	•
Evaluate Compressor and Replace	•		•	•
Evaluate Heat/Cool Relay and Replace			•	
Evaluate Single-Function Defrost Timer and Replace				•
Evaluate Multifunction Defrost Timer and Replace				•
Evaluate Defrost Heater(s) and Replace				•
Evaluate Defrost Heater Terminator and Replace				•
Evaluate Drain Heater(s) and Replace				•
Evaluate Mechanical Defrost Control and Replace			•	
Evaluate Diaphragm-type Defrost Control and Replace			•	
Evaluate Bimetal Outdoor Coil Temperature Sensor and Replace			•	
Evaluate Thermistor-type Temperature Sensor and Replace	•		•	•
Evaluate Solid-state Defrost Control and Replace			•	
Evaluate Defrost Relay and Replace			•	

PERFORMANCE SKILL LEVELS

AIR CONDITIONING/HEAT PUMPS/REFRIGERATION *(Continued)*	Air Conditioning Technician	Furnace and Air Handler Technician	Heat Pump Technician	Refrigeration Technician
Evaluate Outdoor Thermostat(s) and Replace			•	
Evaluate Solenoid Valve Coil and Replace	•	•	•	•
Evaluate Hot Gas Solenoid Valve and Replace	•			•
Evaluate Liquid Line Solenoid Valve and Replace	•			•
Evaluate Reversing Valve and Replace			•	
Evaluate Accumulator and Replace	•		•	•
Evaluate Crankcase Pressure Regulator (CPR) and Replace				•
Evaluate Evaporator Pressure Regulator (EPR) and Replace				•
Evaluate Internal Pressure Regulator (IPR) and Replace				•
Evaluate Operating Pressure Regulator (OPR) and Replace				•
Evaluate Head Master and Replace	•			•
Evaluate Capillary/Distributor Tube(s) and Replace	•		•	•
Evaluate Fixed Orifice Metering Device and Replace	•		•	•
Evaluate Automatic Expansion Valve and Replace	•			•
Evaluate Thermostatic Expansion Valve and Replace	•		•	•
Evaluate Refrigerant Receiver and Replace	•			•
Evaluate Oil Separator and Replace	•			•
FURNACES/AIR HANDLERS				
Evaluate Control Circuit Fuse and Replace	•	•	•	•
Evaluate Heater Element Fuses/Circuit Breakers and Replace		•		
Evaluate Thermocouple and Replace		•		
Evaluate Millivolt (MV) Generator and Replace		•		
Evaluate Transformer and Replace	•	•	•	
Evaluate Fused Link and Replace		•		
Evaluate Door Safety Switch and Replace		•		
Evaluate Spark Ignitor and Replace		•		
Evaluate Hot Surface Ignitor and Replace		•		
Evaluate Flame Sensor and Replace		•		
Evaluate Ignition Module and Replace		•		
Evaluate Gas Valve and Replace		•		
Evaluate Vent Pressure Switch and Replace		•		

FURNACES/AIR HANDLERS *(Continued)*	Air Conditioning Technician	Furnace and Air Handler Technician	Heat Pump Technician	Refrigeration Technician
Evaluate Printed Circuit (PC) Board and Replace	•	•	•	
Inspect Pilot Burner and Orifice and Clean or Replace		•		
Inspect Main Burner and Orifice and Clean or Replace		•		
Evaluate Combination Fan/Limit Control and Replace		•		
Evaluate Fan Switch and Replace		•		
Evaluate Limit Switch and Replace		•		
Evaluate Heater Element Relay and Replace		•		
Evaluate Heater Element Sequencer and Replace		•		
Evaluate Heater Element and Replace		•		
Evaluate Blower Motor Relay and Replace		•		
Evaluate Vent Motor Relay and Replace		•		
Inspect Blower Wheel and Clean or Replace		•		
Inspect Belt Drive Blower Shaft, Bearings and Pulleys and Lubricate or Replace		•		
Evaluate Vent Blower Assembly and Replace		•		
Inspect Primary Heat Exchanger and Clean or Replace		•		
Inspect Secondary Heat Exchanger and Clean or Replace		•		

FOLLOW ACCIDENT/INCIDENT RESPONSE PROCEDURES.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Accident/incident (e.g., property, travel, etc.)
response policy and procedures
Accident/incident-specific checklists
Material Safety Data Sheets (MSDS)
Occupational Safety and Health Association (OSHA)
standards/regulations
First aid kit
Telephone
Accident report and logbook
Incident report and logbook
Disaster policy and procedures
Local, state and federal laws and regulations
Emergency call lists for

- Medical services
- Police department
- Fire department
- Management personnel
- Emergency response team
- Ambulance services

WORK TO BE PERFORMED

Follow accident/incident response procedures.

PERFORMANCE CRITERIA

All accidents/incidents are reported to designated individual.
Details of all accidents/incidents are logged and documented.

Skill is performed with 100% accuracy.

All necessary forms are completed within 24 hours.

Time required to complete the skill varies depending on the information required for documentation and the type of accident/incident.

PERFORMANCE ELEMENTS

1. Assess accident/incident situation.
2. Determine seriousness of accident/incident.
3. Call emergency personnel if necessary.
4. Assist individual(s) by most appropriate means.
5. Establish individual communication checkpoints as required.
6. Direct individuals to appropriate safe areas as required.
7. Report accident/incident to designated individual(s).
8. Complete accident/incident documentation.

PERFORMANCE ASSESSMENT CRITERIA

Follow all insurance, local, state and federal regulations.

PRODUCT

All accident/incident reports and logs are completed and reported to designated individual. Emergency personnel are contacted as required.

PROCESS

Step 2 of performance elements for determining which accident/incident response procedure(s) must be followed and who should be contacted is critical. Step 1 and step 2 of performance elements must be performed prior to remaining steps; however a different sequence may be used for step 3 through step 8 of performance elements.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Unit with defective valve core
Replacement valve core
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Replace Schrader valve core according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is 15 minutes.

PERFORMANCE ELEMENTS

1. Use valve core removal tool designed for replacing core under system pressure.
2. Remove defective valve core according to valve core tool manufacturer's specifications.
3. Replace defective valve core according to valve core tool manufacturer's specifications.
4. Test replacement valve core for leaks.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during replacement of Schrader valve core.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Schrader valve core replacement is completed.

PROCESS

All performance elements for replacing Schrader valve core are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement lockout relay of proper type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate lockout relay for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is 30 minutes. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

Note: Lockout relay is an impedance relay. Coil resistance will be different than standard relay and correct information is available from manufacturer.

1. Follow industry standards and procedures for checking electrical components.
2. Check coil for continuity (resistance).
   a. If reading is infinity or zero, relay is defective and must be replaced; proceed to step 5.
   b. If proper resistance reading is obtained; proceed to step 3.
3. Check circuit for proper voltage.
   a. If proper voltage is present; proceed to step 4.
   b. If no voltage or improper voltage is present, problem is elsewhere in control circuit and further troubleshooting is required.
4. Check for voltage drop across relay contacts. Reading obtained from this step will depend on whether relay is energized (locked-out position) or de-energized (normal position).
   a. If relay is de-energized (normal position), a voltage drop equal to circuit voltage should be obtained. If no voltage drop reading is obtained, further troubleshooting is required.
   b. If relay is energized (abnormal position), no voltage drop reading should be obtained. If voltage drop reading is obtained, relay is defective and must be replaced; proceed to step 5.

5. Replace lockout relay, if necessary.
6. Test replacement lockout relay for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of lockout relay.

PRODUCT

Lockout relay is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing lockout relay are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement contactor of proper type, size and coil voltage
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate contactor for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is 30 minutes. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Check for proper voltage to contactor coil.
   a. If proper voltage is present and contactor does not energize; proceed to step 3.
   b. If proper voltage is present and contactor does energize; proceed to step 4.
   c. If no voltage is present, problem is elsewhere in control circuit and further troubleshooting is required.
3. Check coil for continuity (resistance).
   a. If reading is infinity or zero; proceed to step 6.
   b. If resistance checks okay; proceed to step 4.
4. Check for proper line voltage to contactor contacts.
5. Check for voltage drop across contacts. Contactor must be energized for this check.
   a. If voltage drop is present; proceed to step 6.
   b. If no voltage drop is present, contactor is good.
6. Replace contactor.
7. Test replacement contactor for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of the contactor.

PRODUCT

Contactor is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing contactor are critical and must be performed in sequence.

EVALUATE RUN OR START CAPACITOR AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement capacitor of proper voltage, capacitance and type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate run or start capacitor and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is 30 minutes.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Check for possible short to case on metal-cased capacitors.
3. Check capacitance of capacitor using capacitor tester.
4. Take no action if correct capacitance readings indicate capacitor is good.
5. Incorrect capacitance readings indicate capacitor is defective; proceed to step 4.
6. Replace capacitor.
7. Test replacement capacitor for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of run or start capacitor.

PRODUCT

Run or start capacitor is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing run or start capacitor are critical and must be performed in sequence.

EVALUATE COMPRESSOR POTENTIAL START RELAY AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement compressor potential relay with proper pick up and drop out voltage
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate compressor potential start relay for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is 45 minutes.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Check coil for continuity (resistance).
   a. If coil is open or shorted, start relay is defective and must be replaced; proceed to step 5.
   b. If coil resistance is correct, proceed to step 3.
3. Check continuity (resistance) of relay contacts.
   a. If zero resistance is read, proceed to step 4.
   b. If anything other than zero resistance is read, the relay is defective and must be replaced; proceed to step 5.
4. Operate unit and check for voltage drop across relay contacts.
   a. Zero voltage reading indicates relay is defective and must be replaced; proceed to step 5.
   b. Higher than line voltage reading indicates relay is good.
5. Replace compressor potential start relay.
6. Test replacement compressor potential start relay for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of compressor potential start relay.

PRODUCT

Compressor potential start relay is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing compressor potential start relay are critical and must be performed in sequence.

EVALUATE COMPRESSOR CURRENT START RELAY AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement compressor current start relay with proper current value
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate compressor current start relay for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

The skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace compressor current start relay is 30 minutes. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Determine if compressor is drawing sufficient current for relay to operate.
   a. If current draw is sufficient, proceed to step 3.
   b. If current draw is insufficient, further troubleshooting is required.
3. Determine if voltage is present at compressor start winding terminal.
   a. If proper voltage is present at compressor start winding terminal, relay is good.
   b. If no voltage is present at compressor start winding terminal, relay is defective and must be replaced; proceed to step 4.
4. Replace compressor current start relay.
5. Test replacement current start relay for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of compressor current start relay.

PRODUCT

Compressor current start relay is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing compressor current start relay are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Unit with defective fan blade
Replacement fan blade with proper shaft size, diameter, pitch and correct rotation
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Replace condenser fan blade according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is one hour.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures.
2. Remove defective fan blade using proper tools.
3. Replace fan blade.
4. Test for proper operation of replacement fan blade.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during removal and replacement of condenser fan blade.

PRODUCT

Condenser fan blade is replaced.

PROCESS

All performance elements for replacing condenser fan blade are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement motor with proper size (HP), rotation, speed, voltage, shaft size and frame size
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate blower or fan motor for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace blower or fan motor is one hour. Troubleshooting time will vary. (Additional time is required for removing and reinstalling blower wheel or fan blade.)

PERFORMANCE ELEMENTS

Note: Run or start capacitor skill should be performed before performing this skill, if applicable.

1. Follow industry standards and procedures for checking electrical components.
2. Determine if motor shaft turns freely.
   a. If motor shaft turns freely, proceed to step 3.
   b. If motor shaft does not turn freely, proceed to step 6.
3. Check for proper voltage at motor leads.
   a. If proper voltage is present and motor operates, proceed to step 4.
   b. If proper voltage is present and motor does not operate, proceed to step 5.
   c. If no voltage is present, problem is elsewhere in circuit and further troubleshooting is required.
4. Check current draw of motor.
   a. If current draw is within manufacturer's specifications, motor is good.
   b. If current draw is not within manufacturer's specifications, proceed to step 5.
   c. If no current draw is present, proceed to step 5.

5. Check windings for opens or shorts. Make sure motor is cool enough that internal overload is not open.
   a. If reading is infinity or zero, motor is defective and must be replaced; proceed to step 6.
   b. Winding to winding short (improper resistance reading) indicates motor is defective and must be replaced; proceed to step 6.
6. Replace motor.
7. Test replacement motor for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of blower or fan motor.

PRODUCT

Blower or fan motor is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing blower or fan motor are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement service valve
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate service valve for residential or light commercial unit no larger than 7.5 tons for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is three hours.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for refrigerant leak testing and EPA refrigerant handling regulations.
2. Test service valve for leakage; inspect valve body for deterioration of metal. Analyze results.
   a. Correct operation and no leakage or deterioration indicate that service valve is good.
   b. Incorrect operation, leakage or deterioration indicates that service valve is defective and must be replaced; proceed to step 3.
3. Recover refrigerant from unit.
4. Remove defective service valve and install replacement service valve.
5. Test replacement valve and connections for leaks.
6. Evacuate system according to manufacturer's specifications.
7. Replace recovered refrigerant.
8. Ensure proper refrigerant charge in unit.
9. Test replacement component for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of service valve.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Service valve is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing service valve are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement switch of proper type and range
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate high pressure switch for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill with service valves is one hour. Time required to complete the skill without service valves is three hours.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for refrigerant leak testing, electrical component testing and EPA refrigerant handling regulations.
2. Test high pressure switch for proper operation using proper industry procedure for elevating pressure. Analyze results.
   a. Correct operation indicates switch is good.
   b. Incorrect operation indicates switch is defective and must be replaced; proceed to step 3.
3. Pump unit down or recover refrigerant as applicable.
4. Remove defective high pressure switch and install replacement high pressure switch.
5. Test replacement switch for leaks.
6. Evacuate system and open valves or replace recovered refrigerant as applicable.
7. Test replacement component for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of high pressure switch.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

High pressure switch is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing high pressure switch are critical and must be performed in sequence.

EVALUATE LOW PRESSURE SWITCH AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement switch of proper type and range
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate low pressure switch for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill with service valves is one hour. Time required to complete the skill without service valves is three hours.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for refrigerant leak testing, electrical component testing and EPA refrigerant handling regulations.
2. Test low pressure switch for proper operation using proper industry procedure for lowering pressure. Analyze results.
   a. Continuity reading of infinity indicates switch is good.
   b. Zero or resistance continuity reading indicates switch must be replaced; proceed to step 3.
3. Pump unit down or recover refrigerant as applicable.
4. Remove defective low pressure switch and install replacement low pressure switch.
5. Test replacement switch for leaks.
6. Evacuate system and open valves or replace recovered refrigerant as applicable.
7. Test replacement component for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of low pressure switch.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Low pressure switch is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing low pressure switch are critical and must be performed in sequence.

EVALUATE LOW PRESSURE SWITCH FOR TEMPERATURE CONTROL AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement switch of proper type and range
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate low pressure switch for temperature control for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill with service valves is one hour. Time required to complete the skill without service valves is three hours.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for refrigerant leak testing, electrical component testing and EPA refrigerant handling regulations.
2. Test low pressure switch for proper operation using proper industry procedure for lowering pressure. Analyze results.
   a. Continuity reading of infinity indicates switch is good.
   b. Zero or resistance continuity reading indicates switch must be replaced; proceed to step 4.
3. Pump unit down or recover refrigerant as applicable.
4. Remove defective low pressure switch and install replacement low pressure switch.
5. Test replacement switch for leaks.
6. Evacuate system and open valves or replace recovered refrigerant as applicable.
7. Adjust replacement switch pressure settings for desired cut-in and cut-out pressures.
8. Test replacement component for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of low pressure switch for temperature control.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Low pressure switch for temperature control is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing low pressure switch for temperature control are critical and must be performed in sequence.

EVALUATE THERMOSTAT TEMPERATURE CONTROL AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement thermostat temperature control of proper type and range
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate thermostat temperature control for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is one hour.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Determine temperature at thermostat sensing bulb.
   a. If temperature is at or below set point, proceed to step 4.
   b. If temperature is above set point, proceed to step 3.
3. Lower bulb temperature of thermostat to set point or below; proceed to step 4.
4. Determine if proper voltage is applied to thermostat.
5. Check voltage across switch terminals.
   a. If voltage is present across thermostat switch, thermostat is good.
   b. If no voltage is present across thermostat switch, thermostat is defective and must be replaced; proceed to step 6.
6. Replace thermostat.
7. Test replacement thermostat for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of thermostat temperature control.

PRODUCT

Thermostat temperature control is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing thermostat temperature control are critical and must be performed in sequence.

EVALUATE LIQUID LINE DRIER AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement liquid line drier of proper type for air conditioning and refrigeration (one way), or heat pump (bi-directional)
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate liquid line drier for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill with service valves is one hour. Time required to complete the skill without service valves is three hours.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for refrigerant leak testing and EPA refrigerant handling regulations.
2. Identify type of liquid line drier.
3. Test for temperature drop across liquid line drier.
   a. No temperature drop indicates drier is good.
   b. Temperature drop indicates drier is restricted and must be replaced; proceed to step 5.
4. Pump unit down or recover refrigerant as applicable.
5. Replace liquid line drier with proper type and size.
6. Test replacement drier connections for leaks.
7. Evacuate system and open valves or replace recovered refrigerant as applicable.
8. Test replacement drier for temperature drop across liquid line drier.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of liquid line drier.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Liquid line drier is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing liquid line drier are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement suction line filter
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate suction line filter for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill with service valves is one hour. Time required to complete the skill without service valves is three hours.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for refrigerant leak testing and EPA refrigerant handling regulations.
2. Identify whether unit is an air conditioner or a heat pump. (This is very important in placement of suction line filter.)
3. Check for pressure drop across suction line filter. (Unit must be in operation for this check.)
   a. If pressure drop is within manufacturer's specifications, filter is good.
   b. If pressure drop exceeds manufacturer's specifications, suction line filter must be replaced; proceed to step 4.
4. Pump unit down or recover refrigerant as applicable.
5. Remove restricted filter and install replacement suction line filter in proper location.
6. Test replacement filter connections for leaks.
7. Evacuate system and open valves or replace recovered refrigerant as applicable.
8. Test for pressure drop across replacement filter. (Same as in step 3.)

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of suction line filter.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Suction line filter is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing suction line filter are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement compressor of proper type, size and voltage
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate compressor and replace, if necessary, the according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is four hours.

PERFORMANCE ELEMENTS

Note: Proper refrigerant charge, proper air flows, compressor start components (if used) and compressor run capacitor skills should be determined before performing this skill.

1. Follow industry standards and procedures for refrigerant leak testing, electrical component testing and EPA refrigerant handling regulations.
2. Assure correct rotation on all rotary compressors, scroll compressors and three-phase compressors.
3. Check for proper voltage at compressor motor leads.
   a. If no voltage is present, problem is elsewhere in circuit and further troubleshooting is required.
   b. If voltage is present and compressor runs, proceed to step 4.
   c. If voltage is present and compressor does not run, proceed to step 5.
4. Check current draw of compressor.
   a. If current draw is within manufacturer's specifications, compressor is good.
   b. If current draw is not within manufacturer's specifications, proceed to step 5. Improper refrigerant charge could also cause current readings to be above or below manufacturer's specifications.
   c. If current draw indicates locked rotor condition, proceed to step 7.

5. Evaluate electrical integrity of compressor motor by proper electrical component testing procedures. Make sure that compressor case is cool enough for overload to be closed. Analyze results.
   a. If electrical integrity tests correctly, proceed to step 6.
   b. Open windings, open overload, winding-to-winding, or winding-to-case short indicates that compressor is defective and must be replaced; proceed to step 7.
6. Check suction and discharge pressure of compressor.
   a. Normal reading indicates compressor is okay.
   b. Abnormal reading indicates that abnormal mechanical condition exists within compressor and compressor must be replaced.
7. Recover refrigerant from unit.
8. Replace compressor.
9. Install any replacement driers or filters that are needed. Determine if they are correct type and are installed in proper location for unit being serviced.
10. Test compressor, drier and filter connections for leaks.
11. Evacuate system to manufacturer's specifications.
12. Weigh in proper charge of proper refrigerant.
13. Start unit and determine if it is operating within manufacturer's specifications.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of compressor.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Compressor is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing compressor are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement heat/cool relay of proper type and voltage
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate heat/cool relay for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace heat/cool relay is 30 minutes. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Check coil for proper voltage.
   a. If proper voltage is present and relay does not energize, proceed to step 3.
   b. If proper voltage is present and relay does energize, proceed to step 4.
   c. If no voltage is present, problem is elsewhere in circuit and further troubleshooting is required.
3. Check coil for continuity (resistance) and shorts. If there is a short or no continuity, proceed to step 5.
4. Check for voltage drop across relay contacts. If voltage drop is present, proceed to step 5.
5. Replace relay.
6. Test for proper operation of replacement relay.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of heat/cool relay.

PRODUCT

Heat/cool relay is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing heat/cool relay are critical and must be performed in sequence.

EVALUATE SINGLE-FUNCTION DEFROST TIMER AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement single-function defrost timer of proper type and voltage
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate single-function defrost timer for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace single-function defrost timer is one hour. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Check for proper voltage to single-function defrost timer terminals.
   a. If proper voltage is present, proceed to step 3.
   b. If no voltage is present, problem is elsewhere in defrost circuit and further troubleshooting is required.
3. Determine that defrost control is in defrost mode of operation.
4. Check for voltage at heater terminals of timer.
   a. If voltage is present, timer is good.
   b. If no voltage is present, timer is defective and must be replaced; proceed to step 5.
5. Replace defrost timer.
6. Test replacement timer for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of single-function defrost timer.

PRODUCT

Single-function defrost timer is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing single-function defrost timer are critical and must be performed in sequence.

EVALUATE MULTIFUNCTION DEFROST TIMER AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement multifunction defrost timer of proper type and voltage
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate multifunction defrost timer for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace multifunction defrost timer is one hour. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Check for proper voltage to multifunction defrost timer terminals.
   a. If proper voltage is present, proceed to step 3.
   b. If no voltage is present, problem is elsewhere in defrost circuit and further troubleshooting is required.
3. Determine that defrost control is in defrost mode of operation for stage being tested.
4. Check for voltage at the heater terminals of the timer for the stage being tested.
   a. If voltage is present, timer is good.
   b. If no voltage is present, timer is defective and must be replaced; proceed to step 6.
5. Repeat steps 3 and 4 for the remaining stages of the defrost timer.
6. Replace the defrost timer.
7. Test the replacement timer for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of multifunction defrost timer.

PRODUCT

Multifunction defrost timer is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing multifunction defrost timer are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement defrost heater(s) of proper style and voltage
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate defrost heater(s) for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace defrost heater(s) is two hours. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Determine that defrost control is in defrost mode of operation.
3. Check for proper voltage at defrost heater terminals of defrost control.
   a. If voltage is present, proceed to step 4.
   b. If no voltage is present, problem is elsewhere in defrost circuit and further troubleshooting is required.
4. Check for proper current draw of defrost heater.
   a. If current draw is correct, defrost heater is good.
   b. If current draw is incorrect, proceed to step 5.
5. Isolate defrost heater and check for continuity (resistance) of heater.
   a. If resistance reading is correct, defrost heater is good and problem is elsewhere in circuit; further troubleshooting is required.
   b. If resistance reading is incorrect or open, defrost heater is defective and must be replaced; proceed to step 6.
6. Replace defrost heater.
7. Test replacement defrost heater for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of defrost heater(s).

PRODUCT

Defrost heater(s) is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing defrost heater(s) are critical and must be performed in sequence.

EVALUATE DEFROST HEATER TERMINATOR AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement defrost heater terminator of proper type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate defrost heater terminator for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is two hours.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Make sure that defrost terminator is checked in both hot and cold temperature ranges of terminator.
3. Isolate defrost terminator from defrost circuit.
4. Determine temperature of defrost terminator.
   a. If defrost terminator is in cold position, go to step 5.
   b. If defrost terminator is in hot position, go to step 6.
5. Check continuity (resistance) across defrost terminator contacts. Cold check.
   a. Zero continuity reading indicates that defrost terminator is good in cold position.
   b. Infinity continuity reading indicates that defrost terminator is defective in cold position and must be replaced; proceed to step 8.
6. Check continuity (resistance) across defrost terminator contacts. Hot check.
   a. Infinity continuity reading indicates that defrost terminator is good in hot position.
   b. Zero continuity reading indicates that defrost terminator is defective in hot position and must be replaced; proceed to step 8.
7. Ensure that defrost terminator is checked in both temperature ranges by raising or lowering temperature as applicable.
8. Replace defrost terminator.
9. Test replacement defrost terminator for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of defrost heater terminator.

PRODUCT

Defrost heater terminator is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing defrost heater terminator are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement drain heater(s) of proper style, size and voltage
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate drain heater(s) for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace drain heater(s) is one hour. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Determine that unit is in defrost mode, if applicable.
3. Check for proper voltage to drain heater.
   a. If proper voltage is present, proceed to step 4.
   b. If no voltage is present, further troubleshooting is required.
4. Check drain heater for proper current draw. Because of small current draw associated with drain heater, a current multiplier may be necessary.
   a. If current draw is correct, the drain heater is good.
   b. If current draw is incorrect, proceed to step 5.
5. Isolate drain heater and check drain heater for continuity (resistance).
   a. If resistance reading is correct, drain heater is good and problem is elsewhere in circuit; further troubleshooting is required.
   b. If resistance reading is incorrect or infinity, the drain heater is defective and must be replaced; proceed to step 6.
6. Replace drain heater.
7. Test replacement drain heater for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of drain heater(s).

PRODUCT

Drain heater(s) are evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing drain heater(s) are critical and must be performed in sequence.

EVALUATE MECHANICAL DEFROST CONTROL AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement mechanical defrost control of proper type and voltage
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate mechanical defrost control (cam timer type) for proper operation and replace, if necessary, according to company and manufacturer's guidelines.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace mechanical defrost control is one hour. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Use proper industry standards to lower outdoor coil temperature below activation temperature of defrost control sensing bulb.
3. Check for proper voltage at timer motor leads and switch contacts.
   a. If proper voltage is present and timer motor does not operate, proceed to step 4.
   b. If proper voltage is present and timer motor does operate, proceed to step 5.
   c. If no voltage present, problem is elsewhere in circuit and further troubleshooting is required.
4. Check timer motor windings for continuity (resistance) or shorts. If there is no short or continuity, proceed to step 7.
5. Check for voltage drop across switch contacts. If voltage drop is present, proceed to step 7.
6. Raise coil temperature above defrost termination point to ensure that defrost control terminates defrost cycle.
7. Replace defrost control.
8. Check replacement defrost control for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of mechanical defrost control.

PRODUCT

Mechanical defrost control is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing mechanical defrost control are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement diaphragm-type defrost control of proper type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate diaphragm-type defrost control for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace diaphragm-type defrost control is one hour. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Insert test tee in sensing line from inside cavity of outdoor coil to defrost control. Connect manometer to test tee. Leave outdoor ambient static sensing line connected to defrost control.
3. Use proper industry standards to lower outdoor coil temperature below activation temperature of defrost control sensing bulb.
4. Restrict airflow through outdoor coil until negative pressure needed to operate defrost control is reached. Operate unit until outdoor coil is below required activation temperature.
5. Ensure that when correct coil temperature is reached and correct negative pressure is obtained, that unit initiates defrost cycle.
   a. Initiation of defrost cycle indicates that defrost control is good.
   b. No initiation of defrost cycle indicates that defrost control is defective and must be replaced; proceed to step 6.
6. Check voltage to switch terminals.
   a. Incorrect voltage readings indicate problem in control circuit and further troubleshooting is required.
   b. Correct voltage readings and failure to initiate defrost cycle indicate that defrost control is defective and must be replaced; proceed to step 7.
7. Remove and replace defrost control.
8. Test replacement component for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of diaphragm-type defrost control.

PRODUCT

Diaphragm-type defrost control is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing diaphragm-type defrost control are critical and must be performed in sequence.

EVALUATE BIMETAL OUTDOOR COIL TEMPERATURE SENSOR AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement bimetal outdoor coil temperature sensor of proper type and range
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate bimetal outdoor coil temperature sensor for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is one hour.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Make sure that outdoor coil sensor is checked in both hot and cold positions.
3. Isolate sensor from the circuit.
4. Attach temperature probe to sensor location. Check temperature.
   a. If temperature is above the open specifications of sensor, proceed to step 5.
   b. If temperature is below closed specifications of sensor, proceed to step 6.
5. Check continuity (resistance) of sensor.
   a. If continuity of sensor reads infinity, sensor is good for hot position. Lower coil temperature to check cold position.
   b. If continuity of sensor reads zero or resistance value, sensor is defective and must be replaced; proceed to step 7.
6. Check continuity (resistance) of sensor.
   a. If continuity of sensor reads zero, sensor is good for cold position. Raise coil temperature to check hot position.
   b. If continuity of sensor reads infinity, sensor is defective and must be replaced; proceed to step 7.
7. Replace outdoor coil temperature sensor.
8. Test replacement component.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of bimetal outdoor coil temperature sensor.

PRODUCT

Bimetal outdoor coil temperature sensor is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing bimetal outdoor coil temperature sensor are critical and must be performed in sequence.

EVALUATE THERMISTOR-TYPE TEMPERATURE SENSOR AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement thermistor-type temperature sensor of proper type and range
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate thermistor-type temperature sensor for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is one hour.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Make sure that outdoor coil sensor is checked in both hot and cold positions.
3. Isolate sensor from circuit.
4. Attach temperature probe to sensor location. Check temperature of sensor.
5. Check resistance of sensor. Compare ohm value reading with manufacturer's reference chart. Perform this step for both hot and cold requirements.
   a. If ohm value of sensor is within +/- 2% of reference chart, sensor is good.
   b. If ohm value of sensor is greater or lesser than +/- 2% of reference chart, sensor is defective and must be replaced; proceed to step 6.
6. Replace thermistor-type temperature sensor.
7. Test replacement component.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of thermistor-type temperature sensor.

PRODUCT

The thermistor-type temperature sensor is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing thermistor-type temperature sensor are critical and must be performed in sequence.

EVALUATE SOLID-STATE DEFROST CONTROL AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement solid-state defrost control of proper type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate solid-state defrost control (demand type) for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace solid-state defrost control is 45 minutes. Troubleshooting time will vary. (Defrost control test jumper should be connected to test pins to speed up timing of defrost control.)

PERFORMANCE ELEMENTS

Note: Test bimetal outdoor coil temperature sensor or thermistor-type temperature sensor, as applicable, before proceeding with this skill. Use appropriate sensor skill for defrost control being evaluated.

1. Follow industry standards and procedures for checking electrical components.
2. Attach temperature probe to coil temperature sensor to determine that coil is cold enough to initiate defrost cycle.
   a. If coil is not cold enough, proceed to step 3.
   b. If coil is cold enough, proceed to step 4.
3. Follow industry procedures for lowering coil temperature. When proper temperature has been reached, proceed to step 4.
4. Check for voltage to defrost control.
   a. If no voltage is present, problem is elsewhere in defrost control circuit and further troubleshooting is required.
   b. If voltage is present, connect jumper to test pins to speed up defrost timing cycle.
   c. If defrost cycle is initiated, defrost control is good.
   d. If defrost cycle does not initiate, defrost control is defective and must be replaced; proceed to step 5.

5. Replace defrost control.
6. Test replacement defrost control for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of solid-state defrost control.

PRODUCT

Solid-state defrost control is evaluated and replaced as necessary.

PROCESS

All performance elements for evaluating and replacing solid-state defrost control are critical and must be performed in sequence

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement defrost relay of proper type and voltage
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate defrost relay for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace defrost relay is 45 minutes. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Check continuity (resistance) of relay coil.
   a. If continuity is okay, proceed to step 4.
   b. If coil is open or shorted, proceed to step 6.
3. Determine that unit is in defrost mode of operation. It must be in defrost mode to have power to defrost relay coil. If it is not in defrost mode, power must be applied to relay coil to perform this skill.
4. Check for proper voltage at relay coil terminals.
   a. If voltage is present and relay energizes, proceed to step 5.
   b. If voltage is present and relay does not energize, proceed to step 6.
   c. If no voltage is present and unit is in defrost cycle, problem is elsewhere in defrost control circuit and further troubleshooting is required. (Also see step 3 about power requirements to perform this test.)
5. Check voltage drop across relay contacts.
   a. No voltage drop indicates that relay is good.
   b. Voltage drop indicates that relay is defective and must be replaced; proceed to step 6.
6. Replace defrost relay.
7. Test replacement defrost relay for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of defrost relay.

PRODUCT

Defrost relay is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing defrost relay are critical and must be performed in sequence.

EVALUATE OUTDOOR THERMOSTAT(S) AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement outdoor thermostat(s) of the proper style and type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate outdoor thermostat(s) for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is 45 minutes.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Check temperature at thermostat sensing bulb to assure that it is below setting of thermostat to be tested.
   a. If temperature is below thermostat setting, proceed to step 4.
   b. If temperature is above thermostat setting, proceed to step 3.
3. Insert sensing bulb into container with ice and water that is below setting. If colder temperatures are required, pack dry ice or ice that is below required temperature around sensing bulb.
4. Check for voltage at thermostat contacts.
   a. If voltage is present at proper terminals, thermostat is good.
   b. If no voltage present at proper terminals, thermostat is defective and must be replaced; proceed to step 5.
5. Replace thermostat.
6. Test replacement component for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of outdoor thermostat(s).

PRODUCT

Outdoor thermostat(s) are evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing outdoor thermostat(s) are critical and must be performed in sequence.

EVALUATE SOLENOID VALVE COIL AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement solenoid valve coil of proper voltage and type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate solenoid valve coil for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace solenoid valve coil is 30 minutes. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Check solenoid coil for continuity (resistance).
   a. If continuity (proper resistance) checks okay, proceed to step 3.
   b. If no continuity (infinity) or a short (zero resistance), indicates that the solenoid coil is defective and must be replaced, proceed to step 5.
3. Check for proper voltage at solenoid coil leads. Solenoid coil must be mounted on valve stem before applying voltage to solenoid.
   a. If voltage is present and valve is energized, solenoid coil is good.
   b. If voltage is present and valve is not energized, proceed to step 4.
   c. If no voltage is present, problem is elsewhere in circuit and further troubleshooting is required.
4. Check for a magnetic pull on end of valve stem. If magnetic pull is present, problem is within valve.
5. Replace solenoid coil.
6. Test replacement component for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of solenoid valve coil.

PRODUCT

Solenoid valve coil is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing solenoid valve coil are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement hot gas solenoid valve of proper type and size
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate hot gas solenoid valve for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill with service valves is one hour. Time required to complete the skill without service valves is three hours.

PERFORMANCE ELEMENTS

Note: Solenoid valve coil skill should be performed before performing this skill to verify that solenoid is good. Determine that valve has had sufficient time to cool down from last operation before verifying that valve is or is not leaking.

1. Follow industry standards and procedures for refrigerant leak testing and EPA refrigerant handling regulations.
2. Connect temperature probes to both inlet and outlet sides of valve.
3. Operate unit.
4. Check temperature on both inlet and outlet sides of valve with valve in closed position.
   a. If temperature is lower on outlet side of the valve, valve is not leaking through.
   b. If temperature is the same on outlet side of valve, valve is leaking through and must be replaced; proceed to step 6. (See note at beginning of performance elements.)
5. Check temperature on both inlet and outlet sides of valve with valve in open position. Allow one minute of operation for temperatures to stabilize.
   a. If temperatures are the same on both sides of valve, valve is good.
   b. If temperature on outlet side of valve is lower than inlet temperature, valve is defective and must be replaced; proceed to step 6.

6. Pump unit down or recover refrigerant if applicable.
7. Remove defective valve and install replacement valve.
8. Test replacement valve connections for leaks.
9. Evacuate system and open valves or replace recovered refrigerant if applicable.
10. Test replacement valve for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of hot gas solenoid valve.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Hot gas solenoid valve is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing hot gas solenoid valve are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement liquid line solenoid valve of proper type and size
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate liquid line solenoid valve for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill with service valves is one hour. Time required to complete the skill without service valves is three hours.

PERFORMANCE ELEMENTS

Note: Solenoid valve coil skill should be performed before performing this skill to verify that solenoid is good.

1. Follow industry standards and procedures for refrigerant leak testing and EPA refrigerant handling regulations.
2. Observe system pressures with unit operational but not calling for cooling. Analyze readings.
   a. If low side pressure is at operating low pressure switch setting, proceed to step 3.
   b. If pressures are equal, determine that no voltage is applied to solenoid coil causing valve to be open; proceed to step 7.
3. Adjust thermostat to initiate call for cooling.
4. Observe system pressures. Allow system to stabilize and analyze readings.
   a. If pressures do not change (i.e., unit did not start), proceed to step 5.
   b. If system pressures are within manufacturer's specifications, (i.e., unit started), proceed to step 6.
5. Ensure that control voltage is applied to solenoid coil of valve.
   a. If no voltage is present, problem is elsewhere in control circuit.
   b. If proper voltage is present, proceed to step 7.

6. Adjust thermostat to end call for cooling. Observe pressure readings.
   a. If low side pressure drops to cutoff point, valve is good.
   b. If low side pressure does not drop to cutoff point, valve is defective and needs to be replaced; proceed to step 7.
7. Pump down unit or recover refrigerant as applicable.
8. Replace liquid line solenoid valve.
9. Replace filters or driers as applicable.
10. Test connections for leaks.
11. Evacuate system and open valves or replace recovered refrigerant as applicable.
12. Test replacement component for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of liquid line solenoid valve.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Liquid line solenoid valve is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing liquid line solenoid valve are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement reversing valve of proper type and size
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate reversing valve for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate the valve is one hour and 30 minutes. Time required to evaluate and replace the valve is four hours.

PERFORMANCE ELEMENTS

Note: Solenoid valve coil skill should be performed before performing this skill to verify that solenoid is good.

1. Follow industry standards and procedures, refrigerant leak testing procedures and EPA refrigerant handling regulations.
2. Determine that there is at least 75 PSI difference between high and low sides. (This is sufficient difference in pressure for properly operating valve to shift.)
3. Operate unit and change modes of operation to determine whether valve is shifting.
   a. If valve shifts properly, proceed to step 5.
   b. If valve does not shift properly, proceed to step 4.
4. Follow industry procedures for elevating discharge pressure. Change modes of operation and observe whether valve now shifts.
   a. If valve shifts okay, continue to change modes of operation several times. (This is an attempt to dislodge what was causing valve to stick.)
   b. If valve still fails to shift, it is defective and must be replaced; proceed to step 7.
5. Attach temperature probes to suction port and evaporator coil port of reversing valve body. Temperature probe on coil port must be changed to other coil port when changing modes of operation.

6. Observe temperature readings after ten minutes of operation in heating and cooling modes. Compare temperature readings.
   a. Less than eight degrees temperature difference indicates that reversing valve is not bypassing refrigerant within valve and valve is good.
   b. More than eight degrees temperature difference indicates valve is bypassing refrigerant and must be replaced; proceed to step 7.
7. Recover refrigerant.
8. Remove reversing valve.
9. Install any replacement driers or filters that are needed. Determine that they are correct type and installed in proper location.
10. Replace reversing valve.
11. Test connections for leaks.
12. Evacuate system.
13. Replace recovered refrigerant or replace with new refrigerant of proper charge and type.
14. Test replacement component for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of reversing valve.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Reversing valve is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing reversing valve are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement accumulator of proper size and type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate accumulator for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill with service valves is one hour and 30 minutes. Time required to complete the skill without service valves is three hours.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for refrigerant leak testing and EPA refrigerant handling regulations.
2. Inspect accumulator for leaks and metal deterioration.
   a. If no leaks are found and metal is not deteriorated, proceed to step 3.
   b. If any leaks are found or metal is deteriorated, proceed to step 7 after performing step 3.
3. Pump unit down or recover refrigerant as applicable.
4. Protect fusible plug from excessive heat during testing.
5. Disconnect tubing from the "J" port of accumulator.
6. Measure oil level in accumulator.
   a. If oil level is one-fourth the diameter of "J" tube or less, accumulator is good, proceed to step 8.
   b. If oil level is more than one-fourth the diameter of "J" tube, oil orifice is not letting all the oil return to compressor and accumulator must be replaced; proceed to step 7.
7. Replace accumulator.

8. Install replacement driers or filters as needed. Determine that they are of correct size and type and installed in proper location.
9. Test replacement component connections for leaks.
10. Evacuate system and open valves or replace recovered refrigerant as applicable.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of accumulator.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Accumulator is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing accumulator are critical and must be performed in sequence.

EVALUATE CRANKCASE PRESSURE REGULATOR (CPR) AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement Crankcase Pressure Regulator (CPR) valve of proper type and capacity
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate CPR valve for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate CPR valve is one hour. Time required to evaluate and replace CPR valve with service valves is two hours. Time required to evaluate and replace CPR valve without service valves is four hours.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for refrigerant leak testing and EPA refrigerant handling regulations.
2. Attach refrigerant manifold to appropriate test ports.
3. Record suction pressure reading.
4. Elevate load on evaporator temporarily to increase suction pressure.
   a. If suction pressure at compressor crankcase increases above specifications, CPR valve is defective and must be replaced; proceed to step 5.
   b. If suction pressure at compressor crankcase remains within specifications, CPR valve is good.
5. Pump unit down or recover refrigerant as applicable.
6. Remove defective CPR valve and install replacement CPR valve.
7. Install any replacement driers or filters as applicable.
8. Test all replacement component connections for leaks.
9. Evacuate system to manufacturer's specifications.
10. Open valves or replace recovered refrigerant as applicable.
11. Test replacement CPR valve for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of CPR valve.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

CPR valve is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing CPR valve are critical and must be performed in sequence.

EVALUATE EVAPORATOR PRESSURE REGULATOR (EPR) AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement Evaporator Pressure Regulator (EPR) valve of proper type and capacity
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate EPR valve for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate EPR valve is one hour. Time required to evaluate and replace EPR valve with service valves is two hours. Time required to evaluate and replace EPR valve without service valves is four hours.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for refrigerant leak testing and EPA refrigerant handling regulations.
2. Attach refrigerant manifold to appropriate test ports.
3. Record evaporator pressure reading.
4. Decrease load on evaporator temporarily to lower suction pressure.
   a. If suction pressure at evaporator decreases below specifications, EPR valve is defective and must be replaced; proceed to step 5.
   b. If suction pressure at evaporator remains within specifications, EPR valve is good.
5. Pump unit down or recover refrigerant as applicable.
6. Remove defective EPR valve and install replacement EPR valve.
7. Install any replacement driers or filters as applicable.
8. Test all replacement components for leaks.
9. Evacuate system to manufacturer's specifications.
10. Open valves or replace recovered refrigerant as applicable.
11. Test replacement EPR valve for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of EPR valve.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

EPR valve is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing EPR valve are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement Internal Pressure Regulator (IPR) valve of proper type and capacity
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate IPR valve for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate IPR valve is one hour. Time required to evaluate and replace IPR valve is six hours.

PERFORMANCE ELEMENTS

Note: Determine proper refrigerant charge, proper compressor operation and proper airflows before performing this skill.

1. Follow industry standards and procedures for refrigerant leak testing and EPA refrigerant handling regulations.
2. Attach refrigerant manifold to appropriate test ports.
3. Record system pressures.
   a. If pressure is normal, valve is functioning properly.
   b. If discharge pressure is low for temperatures below 70 degrees, valve is defective and must be replaced; proceed to step 4.
   c. If discharge pressure is high for temperatures above 70 degrees, valve is defective and must be replaced; proceed to step 4.
4. Recover refrigerant.
5. Remove defective IPR valve and install replacement IPR valve.
6. Install any replacement driers or filters as applicable.
7. Test all replacement components for leaks.
8. Evacuate system to manufacturer's specifications.
9. Replace refrigerant as applicable.
10. Test replacement IPR valve for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of IPR valve.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

IPR valve is evaluated and replaced if necessary. IPR valve is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing IPR valve are critical and must be performed in sequence.

EVALUATE OPERATING PRESSURE REGULATOR (OPR) AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement Operating Pressure Regulator (OPR) valve of proper type and capacity
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate OPR valve for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate OPR valve is one hour. Time required to evaluate and replace OPR valve is six hours.

PERFORMANCE ELEMENTS

Note: Determine proper refrigerant charge, proper compressor operation and proper airflows before performing this skill.

1. Follow industry standards and procedures for refrigerant leak testing and EPA refrigerant handling regulations.
2. Attach refrigerant manifold to appropriate test ports.
3. Record liquid temperature and discharge pressure at receiver.
   a. If temperature and pressure are within manufacturer's specifications, valve is functioning properly.
   b. If temperature and pressure are not within manufacturer's specifications, valve is defective and must be replaced; proceed to step 4.
4. Recover refrigerant.
5. Remove defective OPR valve and install replacement OPR valve.
6. Install any replacement driers or filters as applicable.
7. Test all replacement components for leaks.
8. Evacuate system to manufacturer's specifications.
9. Replace refrigerant as applicable.
10. Test replacement OPR valve for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of head master.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

OPR valve is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing OPR valve are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement head master of proper type and capacity
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate head master for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate head master is one hour. Time required to evaluate and replace head master is six hours.

PERFORMANCE ELEMENTS

Note: Determine proper refrigerant charge, proper compressor operation and proper airflows before performing this skill.

1. Follow industry standards and procedures for refrigerant leak testing and EPA refrigerant handling regulations.
2. Attach refrigerant manifold to appropriate test ports.
3. Record system pressures.
   a. If pressure is normal, valve is functioning properly.
   b. If discharge pressure is low for temperatures below 70 degrees; valve is defective and must be replaced; proceed to step 4.
   c. If discharge pressure is high for temperatures above 70 degrees, valve is defective and must be replaced; proceed to step 4.
4. Recover refrigerant.
5. Remove defective head master and install replacement head master.
6. Install any replacement driers or filters as applicable.
7. Test all replacement components for leaks.
8. Evacuate system to the manufacturer's specifications.
9. Replace recovered refrigerant as applicable.
10. Test replacement head master for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of head master.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Head master is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing head master are critical and must be performed in sequence.

EVALUATE CAPILLARY/DISTRIBUTOR TUBE(S) AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement capillary/distributor tubing of correct diameter and length
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate capillary/distributor tube(s) for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill with service valves is two hours. Time required to complete the skill without service valves is four hours.

PERFORMANCE ELEMENTS

Note: Determine proper refrigerant charge, proper compressor operation and proper airflows before performing this skill.

1. Follow industry standards and procedures for refrigerant leak testing and EPA refrigerant handling regulations.
2. Compare operating pressures and temperatures with manufacturer's specifications for existing conditions.
   a. If readings are within manufacturer's specifications, capillary/distributor tube(s) is functioning properly.
   b. If readings are not within manufacturer's specifications, proceed to step 3.
3. Operate system in fan only mode until evaporator coil is dry.
4. Restrict air flow through evaporator coil using proper industry procedure.
5. Operate system in air conditioning mode and make visual observation of refrigerant circuits.
   a. If all refrigerant circuits load up evenly, capillary/distributor tube(s) is functioning properly.
   b. If any refrigerant circuits do not load evenly, or not at all, capillary/distributor tube is restricted or plugged and must be replaced; proceed to step 6.
6. Pump unit down or recover refrigerant as applicable.

7. Replace defective capillary/distributor tube and any filters or driers as applicable.
8. Test replacement component(s) connections for leaks.
9. Evacuate system and open valves or replace recovered refrigerant as applicable.
10. Test replacement capillary/distributor tube for proper operation.
11. Remove airflow restriction.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of capillary/distributor tube(s).

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Capillary/distributor tube(s) is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing capillary/distributor tube(s) are critical and must be performed in sequence.

EVALUATE FIXED ORIFICE METERING DEVICE AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement fixed orifice metering device of proper size and type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate fixed orifice metering device for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill with service valves is two hours. Time required to complete the skill without service valves is four hours.

PERFORMANCE ELEMENTS

Note: Determine proper refrigerant charge, proper compressor operation, proper airflows and unrestricted distributor tubes before performing this skill.

1. Follow industry standards and procedures for refrigerant leak testing and EPA refrigerant handling regulations.
2. Compare operating pressures and temperatures with manufacturer's specifications for existing conditions.
   a. If readings are within manufacturer's specifications, fixed orifice is functioning properly.
   b. If readings are not within manufacturer's specifications, proceed to step 3.
3. Pump unit down or recover refrigerant as applicable.
4. Remove orifice and check for proper size and/or restriction.
   a. If orifice is proper size, reinstall and determine it is functioning properly. (Clean orifice, if necessary, before reinstalling.)
   b. If orifice size is incorrect, replace it with orifice of proper size and type.
5. Replace any filters or driers as applicable.
6. Test replacement component(s) connections for leaks.
7. Evacuate system and open valves or replace recovered refrigerant as applicable.
8. Retest system for operation within manufacturer's specifications.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of fixed orifice metering device.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Fixed orifice metering device is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing fixed orifice metering device are critical and must be performed in sequence.

EVALUATE AUTOMATIC EXPANSION VALVE AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement automatic expansion valve of proper size and type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate automatic expansion valve for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill with service valves is two hours. Time required to complete the skill without service valves is four hours.

PERFORMANCE ELEMENTS

Note: Determine proper refrigerant charge, proper compressor operation, proper airflows and unrestricted distributor tubes before performing this skill.

1. Follow industry standards and procedures for refrigerant leak testing and EPA refrigerant handling regulations.
2. Attach refrigerant manifold to appropriate test ports.
3. Record suction pressure reading.
4. Increase load on evaporator and observe suction pressure reading.
   a. If suction pressure remains within manufacturer's specifications, proceed to step 5.
   b. If suction pressure rises above manufacturer's specifications, valve is defective or improperly adjusted.
      1) Adjust valve to determine if it is out of adjustment. If valve cannot be adjusted, it is defective and must be replaced; proceed to step 6.
      2) If valve can be adjusted, proceed to step 5.

5. Decrease load on evaporator and observe suction pressure reading.
   a. If suction pressure remains within manufacturer's specifications, valve is good.
   b. If suction pressure decreases below manufacturer's specifications, valve is defective or improperly adjusted.
      1) Adjust valve to determine if it is out of adjustment. If valve cannot be adjusted, it is defective and must be replaced; proceed to step 6.
      2) If valve can be adjusted, repeat step 4 to determine proper operation during increased load. If valve remains within manufacturer's specifications during both high and low load conditions, valve is good. If valve fails to remain within manufacturer's specifications, it is Defective and must be replaced; proceed to step 6.
6. Pump down unit or recover refrigerant as applicable.
7. Replace defective valve and any filters or driers as applicable.
8. Test any replacement component connections for leaks.
9. Evacuate system and open valves or replace recovered refrigerant as applicable.
10. Test replacement component for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of automatic expansion valve.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Automatic expansion valve is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing automatic expansion valve are critical and must be performed in sequence.

EVALUATE THERMOSTATIC EXPANSION VALVE AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement thermostatic expansion valve of proper size and type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate thermostatic expansion valve for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill with service valves is two hours. Time required to complete the skill without service valves is four hours.

PERFORMANCE ELEMENTS

Note: Determine proper refrigerant charge, proper compressor operation, proper airflows and unrestricted distributor tubes before performing this skill.

1. Follow industry standards and procedures for refrigerant leak testing and EPA refrigerant handling regulations.
2. Attach refrigerant manifold to appropriate ports.
3. Record system pressures and superheat according to manufacturer's specifications.
4. Simulate increase in load on evaporator by warming sensing bulb of expansion valve.
   a. If suction pressure increases and superheat remains within manufacturer's specifications, proceed to step 5.
   b. If suction pressure remains the same, valve is defective and must be replaced; proceed to step 6.

5. Simulate decrease in load on evaporator by cooling sensing bulb of expansion valve.
   a. If suction pressure decreases and superheat remains within manufacturer's specifications, valve is good.
   b. If suction pressure remains the same, valve is defective and must be replaced; proceed to step 6.
6. Pump unit down or recover refrigerant as applicable.
7. Replace expansion valve and any filters or driers as applicable.
8. Test replacement components for leaks.
9. Evacuate system and open valves or replace recovered refrigerant as applicable.
10. Test replacement component for proper operation and superheat.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of thermostatic expansion valve.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Thermostatic expansion valve is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing thermostatic expansion valve are critical and must be performed in sequence.

EVALUATE REFRIGERANT RECEIVER AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement refrigerant receiver of proper size and type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate refrigerant receiver for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate the receiver is 30 minutes. Time required to evaluate and replace the receiver is four hours.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for refrigerant leak testing and EPA refrigerant handling regulations.
2. Analyze receiver for any metal deterioration.
   a. If no deterioration is found, proceed to step 3.
   b. If any deterioration is found, receiver must be replaced; proceed to step 4.
3. Perform leak testing on all connections, valves, safeties and seams of receiver.
   a. If no leaks are found, receiver is good.
   b. If any leaks are found, repair leaks if applicable. If leaks are in receiver body, it must be replaced; proceed to step 4.
4. Recover refrigerant from unit.
5. Replace receiver and any filters or driers as applicable.
6. Test replacement components for leaks.
7. Evacuate system and replace recovered refrigerant.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of refrigerant receiver.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Refrigerant receiver is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing refrigerant receiver are critical and must be performed in sequence.

EVALUATE OIL SEPARATOR AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement oil separator of proper size and type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures
Environmental Protection Agency (EPA) Refrigerant Handling Certification

WORK TO BE PERFORMED

Evaluate oil separator for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate oil separator is 30 minutes. Time required to evaluate and replace oil separator is four hours.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for refrigerant leak testing and EPA refrigerant handling regulations.
2. Determine proper oil return to compressor.
   a. If oil return is functioning properly, proceed to step 3.
   b. If oil return is functioning incorrectly, oil separator is defective and must be replaced; proceed to step 5.
3. Analyze oil separator for any metal deterioration.
   a. If no deterioration is found, proceed to step 4.
   b. If any deterioration is found, the oil separator must be replaced; proceed to step 5.
4. Perform leak testing on all connections, valves, safeties and seams of oil separator.
   a. If no leaks are found, oil separator is good.
   b. If any leaks are found, repair leaks if applicable. If leaks are in oil separator body, it must be replaced; proceed to step 5.
5. Recover refrigerant from unit.
6. Replace oil separator and any filters or driers as applicable.
7. Test replacement components for leaks.
8. Evacuate system and replace recovered refrigerant.
9. Test replacement component for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of oil separator.

EPA Refrigerant Handling Certification is required to perform this operation.

PRODUCT

Oil separator is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing oil separator are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement control circuit fuse of proper size and type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate control circuit fuse for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to replace fuse is 15 minutes. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Check fuse for continuity (resistance).
   a. Zero resistance indicates that fuse is good.
   b. Infinity resistance indicates that fuse is defective and must be replaced; proceed to step 3.
3. Replace defective fuse.
4. Troubleshoot for cause of fuse failure.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of control circuit fuse.

PRODUCT

Control circuit fuse is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing control circuit fuse are critical and must be performed in sequence.

EVALUATE HEATER ELEMENT FUSES/CIRCUIT BREAKERS AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement heater element fuses/circuit breakers of proper size and type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate the heater element fuses/circuit breakers for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace heater element fuses/circuit breakers is 30 minutes. Troubleshooting time will vary.
to complete the skill is ten minutes.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Determine if protective devices are of correct type and rating.
3. Determine integrity of fuses/circuit breakers by checking voltage at load side of protective device.
   a. Proper voltage indicates that the protective device is good.
   b. No voltage indicates that the protective device is blown or tripped; proceed to step 4.
4. Replace fuse or reset circuit breaker.
5. Troubleshoot for cause of fuse/circuit breaker failure.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of heater element fuses/circuit breakers.

PRODUCT

Heater element fuses/circuit breakers are evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing heater element fuses/circuit breakers are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement thermocouple of proper type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate thermocouple for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is 45 minutes.

PERFORMANCE ELEMENTS

Note: Open circuit – see glossary.

1. Follow industry standards and procedures for checking electrical components.
2. Assure proper pilot flame and thermocouple location.
3. Check open circuit voltage of thermocouple.
   a. If open circuit voltage is between 26 and 32 millivolts, thermocouple is good.
   b. If open circuit voltage is below 26 millivolts, thermocouple is defective and must be replaced; proceed to step 3.
4. Replace thermocouple with one of proper type.
5. Test replacement thermocouple for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of thermocouple.

PRODUCT

Thermocouple is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing thermocouple are critical and must be performed in sequence.

EVALUATE MILLIVOLT (MV) GENERATOR AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement millivolt (MV) generator of proper type and style
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate millivolt (MV) generator for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is 45 minutes

PERFORMANCE ELEMENTS

Note: Open circuit - see glossary.

1. Follow industry standards and procedures for checking electrical components.
2. Assure proper pilot flame and generator location.
3. Determine if generator is 250 MV or 750 MV generator.
4. Check open circuit voltage of 250 MV generator.
   a. If open circuit voltage is between 270 and 350 millivolts, generator is good.
   b. If open circuit voltage is below 250 millivolts, generator is defective and must be replaced; proceed to step 6.
5. Check open circuit voltage of 750 MV generator.
   a. If open circuit voltage is between 600 and 750 millivolts, generator is good.
   b. If open circuit voltage is below 540 millivolts, generator is defective and must be replaced; proceed to step 6.
6. Replace generator with one of proper type.
7. Test replacement generator for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of MV generator.

PRODUCT

MV generator is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing MV generator are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement transformer of proper size, type and voltage
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate transformer for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace transformer is 30 minutes. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Proper output voltage indicates that transformer is good.
   a. If there is no output voltage, proceed to step 3.
   b. Check output voltage of transformer.
3. Check line voltage to transformer.
   a. If line voltage is not present, proceed to step 4.
   b. If line voltage is present, proceed to step 5.
4. Check primary and secondary windings for opens or shorts.
   a. If functioning properly, problem is elsewhere in circuit and further troubleshooting is required.
   b. If open or shorted, proceed to step 5.
5. Replace transformer.
6. Troubleshoot for cause of transformer failure.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of transformer.

PRODUCT

Transformer is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing transformer are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement fused link of proper temperature and type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate fused link for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace fused link is 30 minutes. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Check continuity of fused link.
   a. Zero resistance indicates that fused link is good.
   b. Infinite resistance indicates that fused link is defective and must be replaced; proceed to step 3.
3. Replace defective fused link; proceed to step 4.
4. Operate unit and troubleshoot for cause of fused link failure.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of fused link.

PRODUCT

Fused link is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing fused link are critical and must be performed in sequence.

EVALUATE DOOR SAFETY SWITCH AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement door safety switch of proper type and size
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate door safety switch for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace door safety switch is 30 minutes. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Check for electrical power to door safety switch.
   a. If power is present to door safety switch, proceed to step 4.
   b. If no power is present to door safety switch, proceed to step 3.
3. Troubleshoot for cause of absence of power to door safety switch.
4. Check for voltage from load side of door switch. (Remember to depress switch plunger for this check.)
   a. Proper voltage indicates that switch is good.
   b. No voltage indicates that switch is defective and must be replaced; proceed to step 5.
5. Replace door safety switch.
6. Test replacement door safety switch for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of door safety switch.

PRODUCT

Door safety switch is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing door safety switch are critical and must be performed in sequence.

EVALUATE SPARK IGNITOR AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement spark ignitor of proper style and type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate spark ignitor for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace spark ignitor is 45 minutes. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Examine ignitor for dust, dirt or cracks; clean ignitor and adjust spark gap before proceeding.
3. Observe ignitor during trail for ignition.
   a. If ignitor sparks, ignitor is functioning properly.
   b. If ignitor fails to spark, proceed to step 4.
4. Check for proper voltage at ignitor leads.
   a. If proper voltage is present, ignitor is defective and must be replaced; proceed to step 5.
   b. If proper voltage is not present, troubleshoot for failure in ignition module.
5. Replace ignitor with proper type of ignitor.
6. Test replacement ignitor for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of spark ignitor.

PRODUCT

Spark ignitor is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing spark ignitor are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement hot surface ignitor of proper style and type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate hot surface ignitor for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace hot surface ignitor is 45 minutes. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Examine ignitor for dust, dirt or cracks and proper position.
3. Observe ignitor during trail for ignition.
   a. If ignitor glows, proceed to step 5.
   b. If ignitor does not glow, proceed to step 4.
4. Check for proper voltage at ignitor leads.
   a. If proper voltage is present, ignitor is defective and must be replaced; proceed to step 6.
   b. If proper voltage is not present, troubleshoot for failure in ignition module.
5. Check ohms value of ignitor.
   a. If within range, ignitor is good.
   b. If out of range, proceed to step 6.
6. Replace ignitor with proper type of ignitor.
7. Test replacement ignitor for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of hot surface ignitor.

PRODUCT

Hot surface ignitor is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing hot surface ignitor are critical and must be performed in sequence.

EVALUATE FLAME SENSOR AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement flame sensor of proper style and type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate flame sensor for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace flame sensor is 45 minutes. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Examine flame sensor for dust, dirt, cracks or deteriorated metal if applicable; clean sensor, if applicable, before proceeding.
   a. If sensor has no cracks or deteriorated metal, proceed to step 3.
   b. If sensor has cracks or deteriorated metal, proceed to step 6.
3. Connect microammeter properly to flame sensor lead.
4. Observe flame to assure correct contact with sensor.
5. Determine flame signal strength.
   a. If within manufacturer's specifications, flame sensor is good.
   b. If below manufacturer's specifications, troubleshoot for failure in ignition module.
   c. If no reading is obtained, test ignition module using appropriate skills.
6. Replace flame sensor with proper type of sensor.
7. Test replacement flame sensor for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of flame sensor.

PRODUCT

Flame sensor is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing flame sensor are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement ignition module of the proper type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate ignition module for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace ignition module is 45 minutes. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

Note: Evaluate flame sensor before performing this skill. Determine that flame sensor is properly positioned in flame.

1. Follow industry standards and procedures for checking electrical components.
2. Ensure that thermostat is calling for heat.
3. Check for proper voltage at ignition module terminals.
   a. If proper voltage is present, proceed to step 4.
   b. If no voltage is present, problem is elsewhere in control circuit and further troubleshooting is required.
4. Check timing sequences and determine that correct output is being performed as required.
   a. If timing is correct and outputs are correct, proceed to step 5.
   b. If timing or outputs are incorrect, ignition module is defective and must be replaced; proceed to step 6.
5. Check for proper flame signal strength.
   a. If flame signal is within manufacturer's specifications, ignition module is good.
   b. No flame signal or low flame signal indicates that ignition module is defective and must be replaced; proceed to step 6.
6. Replace ignition module with proper type of ignition module.
7. Test replacement ignition module for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of ignition module.

PRODUCT

Ignition module is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing ignition module are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement gas valve of proper type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate gas valve (thermocouple-type, MV-type or electric-ignition type) for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications and company policy and procedures and industry standards and procedures

Time required to evaluate and replace gas valve is one hour. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

Note: Evaluate thermocouple or MV generator before performing this skill, if applicable.

1. Follow industry standards and procedures for checking electrical components.
2. Ensure that gas valve control knob is in proper position and thermostat is calling for heat.
3. Identify type of gas valve.
   a. If thermocouple-type valve is present, proceed to step 4.
   b. If MV-type or electric ignition-type valve is present, proceed to step 5.
4. Check continuity (resistance) of safety coil.
   a. If continuity of safety coil is functioning properly, proceed to step 5.
   b. If continuity of safety coil indicates open or short, proceed to step 8.
5. Check continuity (resistance) of main gas valve coil(s).
   a. If continuity of main gas valve coil(s) is good, proceed to step 6.
   b. If continuity of main gas valve coil(s) indicates open or short, proceed to step 8.
6. Determine proper voltage to main gas valve coil terminal(s).
   a. If proper voltage is present at main gas valve coil terminal(s) and valve fails to open, proceed to step 8.
   b. If no voltage or improper voltage is present at main gas valve coil terminal(s), problem is elsewhere and further troubleshooting is required.

7. Verify gas inlet and outlet pressure.
   a. If pressures are correct, valve is functioning properly.
   b. If outlet pressure is incorrect, do the following:
      1. Try to adjust to manufacturer's specifications.
      2. If not adjustable, proceed to step 8.
8. Replace gas valve.
9. Test replacement gas valve for leaks and proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of gas valve.

Check current draw and manifold pressure of replacement gas valve to make certain that they are within the manufacturer's specifications.

PRODUCT

Gas valve is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing gas valve are critical and must be performed in sequence.

EVALUATE VENT PRESSURE SWITCH AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement vent pressure switch of proper type and range
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate vent pressure switch for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace vent pressure switch is one hour. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Determine that flue discharge vent is not restricted.
3. Verify switch contact position per manufacturer's specifications.
4. Ensure that thermostat is calling for heat.
5. Install test tee in vent sensing line to activation side of switch diaphragm.
6. Connect manometer to test tee and observe reading.
   a. If reading is within manufacturer's specifications, proceed to step 7.
   b. If reading is not within manufacturer's specifications, troubleshoot for cause of problem.
7. Check voltage to switch contacts.
   a. Proper voltage at proper switch contact indicates that vent switch is good.
   b. No voltage at proper switch contact indicates that vent switch is defective and must be replaced; proceed to step 8.
8. Replace vent switch.
9. Test replacement vent switch for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of vent pressure switch.

PRODUCT

Vent pressure switch is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing vent pressure switch are critical and must be performed in sequence.

EVALUATE PRINTED CIRCUIT (PC) BOARD AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement Printed Circuit (PC) board of proper type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate PC board for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace PC board is one hour. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Determine if thermostat is properly set for desired function. This may require checking PC board in more than one mode of operation.
3. Test for proper input voltage to PC board.
   a. If voltage is correct, proceed to step 4.
   b. If no voltage is present, problem is elsewhere and further troubleshooting is required.
4. Test for proper output voltage per manufacturer's sequence of operation.
   a. If output voltage is correct, check any other functions of PC board. If all outputs have correct output voltage, PC board is good.
   b. Incorrect output voltages from any board functions indicate that board is defective and must be replaced; proceed to step 5.
5. Replace PC board.
6. Test replacement PC board for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of PC board.

PRODUCT

PC board is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing PC board are critical and must be performed in sequence.

INSPECT PILOT BURNER AND ORIFICE AND CLEAN OR REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement pilot burner and orifice of proper style, type and size
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Inspect pilot burner and orifice for proper operation and clean or replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is one hour.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking mechanical components.
2. Remove pilot burner assembly.
3. Inspect pilot burner and orifice for metal deterioration, dirt, dust and carbon (soot) build up.
   a. If no metal deterioration is present, proceed to step 4.
   b. If metal deterioration is present, replace pilot burner assembly.
4. Ensure that orifice is open by running correct size pilot orifice drill through orifice hole. Use caution so that orifice hole is not damaged.
5. Blow any foreign particles from pilot burner assembly using compressed gas that is environmentally safe. Blow out orifice by blowing through orifice in reverse direction of gas flow.
6. Reassemble and reinstall pilot burner assembly.
7. Test pilot burner assembly for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during inspection and cleaning or replacement of pilot burner and orifice.

PRODUCT

Pilot burner and orifice are inspected and cleaned or replaced if necessary.

PROCESS

All performance elements for inspecting and cleaning or replacing pilot burner are critical and orifice and must be performed in sequence.

INSPECT MAIN BURNER AND ORFICE AND CLEAN OR REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement main burner and orifice of proper style, type and size
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Inspect main burner and orifice for proper operation and clean or replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is one hour.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking mechanical components.
2. Remove main burner assembly and orifice.
3. Inspect main burner and orifice for metal deterioration, dirt, dust and carbon (soot) build up.
   a. If no metal deterioration is present, proceed to step 4.
   b. If metal deterioration is present, replace burner/orifice and proceed to step 7.
4. Ensure that orifice is open by running correct size orifice drill through orifice hole. Use caution so that orifice hole is not damaged.
5. Determine that burner holes or ribbon slots are open; this may require drilling or brushing any hardened particles from openings. Blow any foreign particles from main burner assembly using a compressed gas that is environmentally safe. Blow out orifice by blowing through orifice in reverse direction of gas flow.
6. Reinstall main burner orifices and burners.
7. Test main burner assembly for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and cleaning or replacement of main burner and orifice.

PRODUCT

Main burner and orifice are inspected and cleaned or replaced if necessary.

PROCESS

All performance elements for inspecting and cleaning or replacing main burner are critical and orifice and must be performed in sequence.

EVALUATE COMBINATION FAN/LIMIT CONTROL AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement combination fan/limit control of proper type and length
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate fan and limit control for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace combination fan/limit control is one hour. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Ensure that fan and limit switch settings are correct before performing this skill.
3. Determine that thermostat is calling for heat.
4. Check for proper voltage(s) to fan and limit switches.
   a. If voltage(s) are correct, proceed to step 5.
   b. If no voltage or incorrect voltage is present, further troubleshooting is required
5. Determine that fan switch operates blower motor at temperature setting of fan switch.
   a. If fan switch operates blower motor, proceed to step 6.
   b. If no blower motor operation is present, check output voltage of switch.
      (1) If no voltage is present, fan switch is defective and must be replaced; proceed to step 8.
      (2) If voltage is correct, troubleshoot blower motor circuit.
6. Elevate heating medium temperature using approved industry methods. Limit switch should shut off heating medium when heating medium temperature reaches limit setting.
   a. If limit switch interrupts heating medium circuit, proceed to step 7.
   b. If limit switch fails to interrupt heating medium circuit, limit switch is defective and must be replaced; proceed to step 8.

7. Observe operation of switches as heating medium cools down.
   a. Limit switch should allow heating medium to operate after heating medium has cooled approximately 20 degrees below limit switch setting. Correct operation indicates that limit switch is good.
   b. Lower thermostat setting to stop call for heat.
   c. Fan switch should stop blower motor after heating medium has cooled to differential setting of fan switch. Correct operation indicates that fan switch is good.
   d. Incorrect operation of either step 7a or step 7c indicates that fan and limit switch is defective and must be replaced; proceed to step 8.
8. Replace fan and limit switches.
9. Test replacement fan and limit switch for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of combination fan/limit control.

PRODUCT

Combination fan/limit control is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing combination fan/limit control are critical and must be performed in sequence.

EVALUATE FAN SWITCH AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement fan switch of proper type and range
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate fan switch for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace fan switch is one hour. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Ensure that fan switch settings are correct before performing this skill.
3. Determine that thermostat is calling for heat.
4. Check for proper voltage to fan switch.
   a. If voltage is correct, proceed to step 5.
   b. If no voltage or incorrect voltage is present, further troubleshooting is required.
5. Determine that fan switch operates blower motor at temperature setting of fan switch.
   a. If fan switch operates blower motor, proceed to step 6.
   b. If no blower motor operation is present, check output voltage of switch.
      1) If no voltage is present, fan switch is defective and must be replaced; proceed to step 7.
      2) If voltage is correct, troubleshoot blower motor circuit.
6. Lower thermostat setting to stop call for heat.
   a. Fan switch should stop blower motor after heating medium has cooled to differential setting of fan switch. Correct operation indicates that fan switch is good.
   b. Incorrect operation indicates that fan switch is defective and must be replaced; proceed to step 7.
7. Replace fan switch.
8. Test replacement fan switch for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of fan switch.

PRODUCT

Fan switch is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing fan switch are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement limit control of proper type and range
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate limit switch for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is one hour.

PERFORMANCE ELEMENTS

Note: Some limit switches (auxiliary) may be of manual reset type.

1. Follow industry standards and procedures for checking electrical components.
2. Determine that thermostat is calling for heat.
3. Elevate heating medium temperature using approved industry methods.
4. Observe operation of limit switch when heating medium temperature reaches limit switch setting.
   a. If limit switch interrupts heating medium circuit and/or causes reset button to activate, proceed to step 5, if applicable.
   b. If limit switch fails to interrupt heating medium circuit or to activate reset button (if applicable), limit switch is defective and must be replaced; proceed to step 7.
5. Lower thermostat setting to stop call for heat.
6. Observe operation of limit switch as heating medium cools down.
   a. Automatic reset type of limit control should allow heating medium to operate after heating medium has cooled below limit switch differential. Correct operation indicates that limit switch is good.
   b. Manual reset type of limit switch should not allow heating medium to operate when heating medium has cooled down. After heating medium has cooled, push reset button and heating medium should operate. Correct operation indicates that limit switch is good.
   c. Incorrect operation of either step 6a or step 6b indicates that limit switch is defective and must be replaced; proceed to step 7.

7. Replace limit switch.
8. Test replacement limit switch.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of limit switch.

PRODUCT

Limit switch is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing limit switch are critical and must be performed in sequence.

EVALUATE HEATER ELEMENT RELAY AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement heater element relay of proper type and capacity
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate heater element relay for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace heater element relay is one hour. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components,
2. Determine that thermostat is calling for heat.
3. Check for proper voltage to heater element relay contacts.
   a. If proper voltage is present, proceed to step 4
   b. If proper voltage is not present, troubleshoot for cause.
4. Check for proper voltage to heater element relay coil terminals.
   a. If proper voltage is present and relay is energized, proceed to step 5.
   b. If proper voltage is present and relay does not energize, proceed to step 6.
   c. If proper voltage is not present, troubleshoot for cause.
5. Check for voltage on load side of heater element relay contacts.
   a. If proper voltage is present, relay is good.
   b. If no voltage or improper voltage is present, relay contacts are defective and relay must be replaced; proceed to step 6.
6. Replace heater element relay.
7. Test replacement heater element relay for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of heater element relay.

PRODUCT

Heater element relay is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing heater element relay are critical and must be performed in sequence.

EVALUATE HEATER ELEMENT SEQUENCER AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement heater element sequencer of proper type and capacity
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate heater element sequencer for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace heater element sequencer is one hour. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Determine that thermostat is calling for heat.
3. Check for proper voltage to sequencer main contacts and auxiliary contacts if applicable.
   a. If proper voltage is present, proceed to step 4.
   b. If proper voltage is not present, troubleshoot for cause.
4. Check for proper voltage to sequencer heater terminals.
   a. If proper voltage is present, proceed to step 5.
   b. If proper voltage is not present, troubleshoot for cause.
5. Ensure that sequencer times out and closes main and/or auxiliary contacts. Check for voltage at load side of sequencer contacts.
   a. If proper voltage is present, proceed to step 6.
   b. If no voltage or improper voltage is present, sequencer is defective and must be replaced; proceed to step 8.
6. Lower thermostat setting to stop call for heat.
7. Ensure that sequencer times out and opens main and/or auxiliary contacts.
8. Replace heater element sequencer.
9. Test replacement heater element sequencer.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of heater element sequencer.

PRODUCT

Heater element sequencer is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing heater element sequencer are critical and must be performed in sequence.

EVALUATE HEATER ELEMENT AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement heater element of proper size and type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate heater element for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate heater element is 30 minutes. Time required to replace heater element varies according to number of elements being replaced. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking electrical components.
2. Determine that proper voltage is applied to heater element terminals.
   a. If proper voltage is present, proceed to step 3.
   b. If proper voltage is not present, troubleshoot for cause.
3. Check amp draw of element and compare with specifications. (Remember to use correct multiplier if nonstandard voltage is present.)
   a. If amp draw is within specifications, element is good.
   b. If amp draw is not within the specifications, element is defective and must be replaced; proceed to step 4.
4. Replace heater element.
5. Test replacement heater element for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of heater element.

PRODUCT

Heater element is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing heater element are critical and must be performed in sequence.

EVALUATE BLOWER MOTOR RELAY AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement blower motor relay of proper type and capacity
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate blower motor relay for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace blower motor relay is 30 minutes. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

Note: For integrated circuit, see Skill 60.

1. Follow industry standards and procedures for checking electrical components.
2. Determine that thermostat is set for fan operation.
3. Check voltage to blower motor relay contacts.
   a. If proper voltage is present, proceed to step 4.
   b. If proper voltage is not present, troubleshoot for cause.
4. Check voltage to blower motor relay coil terminals.
   a. If proper voltage is present and relay energizes, proceed to step 5.
   b. If proper voltage is present and relay fails to energize, proceed to step 6.
5. Check for voltage on load side of blower motor relay contacts.
   a. If voltage is present, blower motor relay is good.
   b. If voltage is not present, blower motor relay is defective and must be replaced; proceed to step 6.
6. Replace blower motor relay.
7. Test replacement blower motor relay.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of blower motor relay.

PRODUCT

Blower motor relay is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing blower motor relay are critical and must be performed in sequence.

EVALUATE VENT MOTOR RELAY AND REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement vent motor relay of proper type
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate vent motor relay for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace vent motor relay is 30 minutes. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

Note: For integrated circuit, see Skill 60.

1. Follow industry standards and procedures for checking electrical components.
2. Determine that thermostat is calling for heat.
3. Check voltage to vent motor relay contacts.
   a. If proper voltage is present, proceed to step 4.
   b. If proper voltage is not present, troubleshoot for cause.
4. Check voltage to vent motor relay coil terminals.
   a. If proper voltage is present and relay energizes, proceed to step 5.
   b. If proper voltage is present and relay fails to energize, proceed to step 6.
   c. If no voltage is present, troubleshoot for cause.
5. Check for voltage on load side of vent motor relay contacts.
   a. If voltage is present, vent motor relay is good.
   b. If voltage is not present, vent motor relay is defective and must be replaced; proceed to step 6.
6. Replace vent motor relay.
7. Test replacement vent motor relay.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of vent motor relay.

PRODUCT

Vent motor relay is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing vent motor relay are critical and must be performed in sequence.

INSPECT BLOWER WHEEL AND CLEAN OR REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement blower wheel of proper size, rotation and shaft size
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Inspect blower wheel for proper operation and clean or replace, if necessary, according to company and manufacturer's specifications

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is two hours.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking mechanical components.
2. Inspect blower wheel for dirt and/or lint build up.
   a. If no dirt or lint build up is present on wheel, proceed to step 3.
   b. If dirt or lint is build up is present on wheel, proceed to step 4.
3. Run blower and observe wheel for alignment and vibration.
   a. If blower wheel alignment is proper and there is no vibration, wheel is good; proceed to step 5.
   b. If the blower wheel alignment is poor or vibrates, replace blower wheel.
4. Remove blower assembly and clean blower wheel. After cleaning blower wheel, reassemble blower assembly; go to step 3.
5. Reinstall blower assembly.
6. Test blower for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during inspection and cleaning or replacement of blower wheel.

PRODUCT

Blower wheel is inspected and cleaned or replaced if necessary.

PROCESS

All performance elements for inspecting and cleaning or replacing blower wheel are critical and must be performed in sequence.

INSPECT BELT DRIVE BLOWER SHAFT, BEARINGS AND PULLEYS AND LUBRICATE OR REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement belt drive blower shaft, bearings and pulleys of proper style, type and size
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Inspect belt drive blower shaft, bearings and pulleys for proper operation and lubricate or replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to complete the skill is two hours.

PERFORMANCE ELEMENTS

1. Follow industry standards and procedures for checking mechanical components.
2. Remove drive belt and determine that blower turns freely.
3. Inspect blower shaft, bearings and pulleys for any looseness/wear or excessive end play.
   a. If blower shaft has no looseness/wear in bearings or excessive end play, lubricate bearings.
   b. If blower shaft has any looseness/wear in bearings or excessive end play, proceed to step 4.
4. Replace blower shaft and bearings.
5. Inspect pulleys (sheaves) and belts for wear; replace or reinstall.
6. Test replacement components.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during inspection and lubrication or replacement of belt drive blower shaft, bearings and pulleys.

PRODUCT

Belt drive blower shaft, bearings and pulleys are inspected and lubricated or replaced if necessary.

PROCESS

All performance elements for inspecting and lubricating or replacing belt drive blower shaft, bearings and pulleys are critical and must be performed in sequence.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement vent blower assembly of proper type and manufacturer
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Evaluate vent blower assembly for proper operation and replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to evaluate and replace vent blower assembly is two hours. Troubleshooting time will vary.

PERFORMANCE ELEMENTS

Note: Check capacitor.

1. Follow industry standards and procedures for checking electrical components.
2. Determine that flue vent is not restricted.
3. Determine that thermostat is calling for heat.
4. Check voltage at motor leads.
   a. If voltage is present and motor runs, proceed to step 5.
   b. If voltage is present and motor does not run, proceed to step 6.
   c. If no voltage is present, problem is elsewhere in vent blower motor circuit and further troubleshooting is required.
5. Check current draw of motor.
   a. If current draw is within manufacturer's specifications, motor is good; proceed to step 7.
   b. If current draw is excessive according to manufacture's specifications, proceed to step 6.
   c. If no current draw is present, proceed to step 6.
6. Check motor windings for continuity (resistance) and shorts.
   a. If there is no continuity or if resistance readings are incorrect, proceed to step 8.
   b. Check that blower turns freely and that nothing is causing blower to bind up. If locked rotor condition exists or blower is binding up, proceed to step 8.

7. Connect manometer to blower assembly and check that pressures meet manufacturer's specifications.
   a. If blower is within manufacturer's specifications, blower is good.
   b. If blower does not meet manufacturer's specifications, proceed to step 8.
8. Verify that restrictor plate (if used) is in proper location and replace vent blower assembly.
9. Test replacement vent blower for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during evaluation and replacement of vent blower assembly.

PRODUCT

Vent blower assembly is evaluated and replaced if necessary.

PROCESS

All performance elements for evaluating and replacing vent blower assembly are critical and must be performed in sequence.

INSPECT PRIMARY HEAT EXCHANGER AND CLEAN OR REPLACE

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement primary heat exchanger of proper type and size
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Inspect primary heat exchanger for proper operation and clean or replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to inspect primary heat exchanger is two hours. Time required to inspect and replace primary heat exchanger is six hours.

PERFORMANCE ELEMENTS

Note: Skill 59 has been performed.

1. Follow industry standards and procedures for checking mechanical components.
2. Inspect primary heat exchanger for dirt and/or soot.
   a. If no dirt or soot is visible in heat exchanger, proceed to step 3.
   b. If dirt or soot is visible in heat exchanger, follow manufacturer's specifications for cleaning and proceed to step 3.
3. Test heat exchanger for leaks using proper test equipment/kit and according to manufacturer's specifications.
   a. If heat exchanger passes test, it is good.
   b. If heat exchanger fails test, it is defective and must be replaced; proceed to step 4.
4. Replace primary heat exchanger or furnace if required.
5. Test replacement components for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during inspection and cleaning or replacement of primary heat exchanger.

PRODUCT

Primary heat exchanger is inspected and cleaned or replaced if necessary.

PROCESS

All performance elements for inspecting and cleaning or replacing primary heat exchanger are critical and must be performed in sequence.

INSPECT SECONDARY HEAT EXCHANGER AND CLEAN OR REPLACE.

SKILL STANDARD

CONDITIONS OF PERFORMANCE

Given the following:

Replacement secondary heat exchanger of proper type and size
Tool kit
Manufacturer's specifications
Industry standards and procedures
Company policy and procedures

WORK TO BE PERFORMED

Inspect secondary heat exchanger for proper operation and clean or replace, if necessary, according to company and manufacturer's specifications.

PERFORMANCE CRITERIA

Skill is performed according to manufacturer's specifications, company policy and procedures and industry standards and procedures.

Time required to inspect secondary heat exchanger is two hours. Time required to inspect and replace secondary heat exchanger is six hours.

PERFORMANCE ELEMENTS

Note: Skill 59 has been performed.

1. Follow industry standards and procedures for checking mechanical components.
2. Inspect secondary heat exchanger for dirt and/or soot.
   a. Check condensate drain system for obstructions.
   b. If no dirt or soot is visible in heat exchanger, proceed to step 3.
   c. If dirt or soot is visible in heat exchanger, follow manufacturer's specifications for cleaning; proceed to step 3.
3. Test heat exchanger for leaks using proper test equipment/kit and according to manufacturer's specifications.
   a. If heat exchanger passes test, it is good.
   b. If heat exchanger fails test, it is defective and must be replaced; proceed to step 4.
4. Replace secondary heat exchanger or furnace if required.
5. Test replacement components for proper operation.

PERFORMANCE ASSESSMENT CRITERIA

Observe accuracy and efficiency of performance during inspection and cleaning or replacement of secondary heat exchanger.

PRODUCT

Secondary heat exchanger is inspected and cleaned or replaced if necessary.

PROCESS

All performance elements for inspecting and cleaning or replacing secondary heat exchanger are critical and must be performed in sequence.

Many of the items listed are typically found on service vehicles while others are readily available at the warehouse or supply store.

110V Kit Quick Start
220V Kit Quick Start
Allen Wrenches
Acetylene B-tank
Acetylene Regulator-Hose & Tips ((turbo)
Amprobe
Ballpeen Hammer
Capacitor Tester
Chisel Set
Combination Wrench Set
Crescent Wrenches (8" and 12")
Diagonal Cutters
Drill 3/8"
Drill bits
Electronic Thermometers (pocket and thermocouple)
File Set
First Aid Kit
Flare/Swage Set
Fuse Pullers
Gloves
Hack Saw
Hand Formers
Hand Tool Set – Refrigeration
Heat Anticipator Meter
Industrial Flashlight
Leak Detector and associated supplies
Manifold Set with low loss fittings on the hoses
Manometer, 0" to 16" WC
Micro-Ammeter
Micron Gauge
Multimeter
Nitrogen Tank, Regulator and Relief Valve
Nut Driver Set
Orifice Drill Set (number 1 through 80)
Oxy-Acetylene Brazing/Welding Unit
Pinch-Off Tool
Pitot Tubes
Pipe Threading Dies
Pipe Vise
Pipe Wrench Set (10", 12" and 14")
Pliers (Slip Joint/Needle Nose/Linesman/Locking)
Pop Rivets
Pop Rivet Tool
Reamers
Refrigerant
Refrigerant Oil
Refrigerant Recovery Machine(s) and Tank(s)
Safety Glasses
Schrader Valve Core Removal Tool
Scratch Awl
Screwdriver Set (Straight and Philips)
Service Valve Wrenches
Soldering Gun
Soldering and brazing material including proper flux
Sockets and Ratchet Set – 1/4" & 3/8" Drive (1/2" drive optional)
Tap and Die Set
Tape Measure or Folding Ruler
Tin Snips - Right/Left/Straight
Tubing Access Adapter Kit
Tubing Bender Set
Tubing Cutter Kit
Tubing Deburring Tool
Tubing/Wrench Set
Vacuum Cleaner
Vacuum Pump and Oil for Pump
Wheel/Fan Puller Set
Wire Terminals and Crimpers
Wire Strippers

Accumulator	Shell placed in suction line of refrigeration system to prevent liquid refrigerant from entering compressor by vaporizing liquid refrigerant.
Air	Mixture of oxygen, nitrogen and traces of other gases. It may also contain moisture known as humidity.
Air filter	Device used to trap dirt particles within duct system.
Alternating current (AC)	Electrical current which changes direction periodically, usually 60 times per second.
Altitude correction	Change in atmospheric pressure at higher altitudes which may affect furnace operation at those higher altitudes.
Ambient temperature	Temperature that surrounds an object
Ammeter	Meter calibrated in amperes to measure current flow in a current.
Amperage (Amps)	Amount of current that flows in an electrical current.
Atmospheric pressure	Pressure exerted on earth by atmosphere; considered to be 14.7 PSIG.
Automatic control	Device that controls various functions of a piece of equipment.
Automatic expansion valve	Metering device in refrigeration system that controls amount of liquid refrigerant that enters evaporator. This valve is pressure controlled.
Balancing damper	Device normally used to balance air flow in a duct system. It is normally used in multiple trunk duct systems. Also see manual damper, motorized damper and volume damper.
Balancing valve	Device used to control flow of water in a hydronic system. This device may be manual or motorized.
Bearing	Device used to support and align moving parts in a piece of equipment. It is designed to be a low friction device.
Boiling point	Temperature at which liquid will boil at 14.7 PSIG (e.g., water will boil at 212 degrees Fahrenheit).
Braze	To join metals with a nonferrous filler using heat between 800 degrees Fahrenheit and melting point of the metals.
British Thermal Unit (BTU)	Amount of heat required to raise one pound of water one degree Fahrenheit.

Bypass	Pipe or duct controlled by a valve or damper to short circuit a gas or liquid.
Calibrate	To verify that gauges, meters, etc. are reading correctly compared to a known standard.
Capacitor	Electrical device capable of storing electrical energy.
Capacity	Amount of a substance that may be held in a container; ability of a substance to absorb or reject another substance.
Capillary tube	A tube of small diameter that regulates amount of gas or fluid that may flow through it depending upon pressure applied.
Centigrade scale	A temperature scale on which freezing is zero degrees and boiling point of water is 100 degrees.
Centrifugal compressor	Compressor that uses centrifugal force to compress a vapor.
Change of state	Process of changing a substance from one state to another (e.g., a liquid to a vapor, a solid to a liquid, etc.).
Charge	Amount of product for a given device or system.
Charging station	Self-contained device designed for evacuating and charging refrigerant and/or oil into a refrigeration system.
Check valve	Device that allows a gas or liquid to flow in only one direction.
Circuit	Tubing, piping or wiring that allows flow from the energy source through the circuit and return to the energy source.
Circuit breaker	Safety device which protects an electrical circuit from being overloaded.
Circuit, parallel	Circuit where two or more devices are connected in such a manner that they may operate at same time from one controlling device. The phrase "parallel circuit" is most commonly referred to as an electrical circuit. There are however, other types of "parallel circuits" (e.g., refrigerant circuits in an evaporator coil or condenser coil for an air conditioning system).
Circuit, series	Circuit where two or more devices are connected in such a manner that the total flow must pass through each device. The phrase "series circuit" is most commonly referred to as an electrical circuit, however there are other types of "series circuits" (e.g., refrigerant circuit where all of the refrigerant passes through each drier, filter and metering device of the unit).

Circuit, series-parallel	Circuit where three or more devices are connected in such a manner that total flow must pass through at least one of the devices in the circuit before passing through the other devices. The phrase "series-parallel circuit" is most commonly referred to as an electrical circuit, however there are other types of "series-parallel circuits" (e.g., refrigerant circuit where all of the refrigerant passes through each of the components in the system).
Closed circuit	Complete circuit in which flow of an energy source occurs. The phrase "closed circuit" is most commonly referred to as an electrical circuit, however there are other types of "closed circuits" (e.g., refrigerant circuit, hydronic heating circuit, etc.).
Coefficient of Performance (COP)	Ratio of energy derived from energy used. Heat pumps are rated by the term COP.
Compressor	Device used to increase pressure of a gaseous product. Also see: centrifugal compressor, open drive compressor, reciprocating compressor, rotary compressor, screw compressor and scroll compressor.
Condensate	Moisture derived from removing the heat from a vapor to bring it below the dew point temperature.
Condenser	Component in which enough heat is removed from a vapor to cause a change of state to a liquid.
Conductor	A material capable of carrying electrical energy.
Contaminant	Moisture, dirt or some other material that is foreign to the refrigerant or oil within the refrigeration system.
Control	Device used to control a piece of equipment, usually pressure or temperature responsive.
Control system	Controls or other components used to operate a piece of equipment. Most control systems are for automatic control of equipment.
Control valve	Valve used to control the flow of gases or liquids, usually controlled by a remote signal.
Current	Flow of electrical energy in a conductor.
Current relay	Device used for starting an electric motor by using the current flow in the motor circuit to operate the relay.
Cut-in	Point at which the controlling device will start the equipment.

Cutout	Point at which the controlling device will stop the equipment.
Cycle	Operation of a piece of equipment from beginning to end of operation.
Damper	See balancing damper, manual damper, motorized damper and volume damper.
Defrost	To remove frost or ice from a component.
Defrost cycle	Operation of removing the frost or ice from a piece of equipment.
Defrost timer	Component that controls defrost cycle. Also referred to as a defrost control.
Degree	Unit of measure on a temperature scale. Also used in reference to the measurement of angles.
Diaphragm	Flexible material usually made of thin rubber or metal to separate chambers.
Differential	Difference between the cut-in and cutout points of a control.
Drier	Device for the removal of moisture from the refrigerant.
Dry bulb	Thermometer used to measure ambient air temperature.
Duct	Type of pipe through which air is delivered in a forced air system.
Electric defrosting	Method of defrosting by using an electric element to heat the component.
Electric heating	Heating system using resistance elements or resistance wire powered by electricity as the energy source.
Electronic leak detector	Electronic device used to sense refrigerant vapor.
Energy	Ability to do work.
Evacuation	Removal of air, moisture and other gases from within the refrigerant system.
Evaporator	Component in which enough heat is added to a liquid to cause a change of state to a vapor.
Expansion valve	Metering device in a refrigeration system that controls the amount of liquid refrigerant that enters the evaporator. It may be an automatic expansion valve or a thermostatic expansion valve.
Fahrenheit scale	Temperature scale on which freezing is 32 degrees and the boiling point of water is 212 degrees.
Filter	See air filter, refrigerant filter and refrigerant filter drier.

Flue	Passage through which the products of combustion are vented to the atmosphere; usually metal or PVC pipes.
Flux	Substance used in soldering or brazing to prevent oxides from forming during the process.
Foam leak detector	Soap solution or other special mixture used to brush or spray over areas of suspected leaks.
Freezer	Any device used for the freezing of perishable foods or other items.
Freezing point	Point at which a liquid will change to a solid when heat is removed.
Furnace	Part of a heating system in which energy in some form is converted to heat.
Fuse	Non-resetting safety device which protects an electrical circuit from being overloaded.
Fusible link	High temperature safety device that opens an electrical circuit or controls some type of mechanical device if high temperatures occur in a system.
Fusible plug	High temperature safety plug designed to melt and relieve excessive pressure within a container (e.g., refrigerant receiver or accumulator).
Gas	Vapor state of a substance.
Gauge	Instrument used to measure pressure either above or below atmospheric pressure.
Gauge manifold	Device with gauges, valves and flexible hoses for testing, charging or evacuating a refrigeration system.
Gauge port	Opening provided for installation of a gauge on the equipment. In some cases access valves are attached at this point.
Ground wire:	Electrical wire that will safely carry electricity to ground in the event of an electrical short. This wire is normally either bare or green in color.
Halide torch	Type of torch used to detect halogen refrigerant leaks.
Head pressure	Pressure against which the compressor must pump to deliver the gas.
Head pressure control	Pressure operated device that opens the compressor control circuit in the event of high pressure. Also used to cycle condenser fans and/or operate shutters for cold weather operation of equipment.

Heat exchanger	Device that removes heat from one substance and adds it to another.
Hermetic compressor	Unit in which the compressor and motor are sealed inside a housing.
High pressure cutout	Control in the high pressure side of the system that will open an electrical circuit when a predetermined pressure is reached.
Hot gas	Gas leaving the discharge of a compressor.
Hot gas bypass	Connection from the hot discharge gas to the suction side of the compressor. This is usually used as a capacity control and does not pass hot gas all the time.
Hot gas defrost	Method of defrost that uses the hot gas to remove the frost or ice.
Hydronic	Heating system that uses hot water as the heat transfer medium.
Hygroscopic	Ability of a substance to absorb and release moisture.
Instrument	Device for measuring, recording, controlling, testing, etc.
Integrated furnace control (IFC)	Electronic control board that controls several functions in the operation of a furnace. Also see printed circuit (PC) board.
Kilowatt	Unit of measure of electrical power.
Kilowatt hour	Unit of measure of electrical power equal to 1000 watt hours.
Latent heat	Heat that is added or removed from a substance to cause a change of state but cannot be measured by a thermometer; change of state without a change in temperature.
Leak detector	Device used to locate leaks. There are several types of leak detectors (e.g., soap bubbles, halide torch, electronic, ultrasonic and ultraviolet).
Limit control	Safety control that will stop the operation of a piece of equipment if it becomes dangerous to continue operation.
Liquid line	Refrigerant line carrying liquid refrigerant from the receiver or condenser to the evaporator.
Liquid receiver	Cylinder device connected to the outlet of the condenser to store liquid refrigerant.
Locked rotor amps	Amperage flowing in a circuit when a motor is locked up and cannot turn or upon starting.
Low pressure control	Pressure control that operates a circuit when a predetermined pressure is reached.
Manifold	Portion of a system in which several branches are connected.

Manometer	Instrument used to measure low pressures, usually in inches of water column. Some manometers use a gauge oil in place of water. There are also mercury manometers.
Manual damper	Device used to control the flow of air.
Manual valve	Valve that is operated manually.
Megohm	One megohm equals one million ohms of electrical resistance.
Megohmmeter	Instrument used to measure extremely high resistance.
Meter	Instrument used to make measurements. Also a unit of measurement in the metric system.
Metric system	Decimal system of measurement.
Micron	Extremely small unit of measurement. One micron equals 1/1000 mm.
Micron gauge	Very accurate instrument used to measure the vacuum within a refrigeration system during evacuation.
Milli	One thousandth of a specified unit (e.g., millivolt is 1/1000 of a volt, milliamp is 1/1000 of an amp).
Miscibility	Ability of different substances to mix together.
Motorized damper	Device used to control the flow of air that is driven by a motor controlled by a remote control.
Muffler	Device used in the compressor discharge line to silence the discharge pulsations; also helps eliminate pulsation vibrations.
Normally closed contacts	Set of contacts that are closed when the device is in a de-energized condition.
Normally open contacts	Set of contacts that are open when the device is in a de-energized condition.
Off cycle	Period of time when equipment is not operating. Some equipment is described by the term "off cycle crankcase heat," which means that the compressor winding is used for heating purposes during the off cycle.
Ohm	Unit of measure for electrical resistance.
Ohmmeter	Instrument used to measure electrical resistance.
Oil pressure control	Safety control that will shut down equipment in the event of oil pressure failure. This control is not normally found on small equipment.
Oil separator	Device that separates oil from refrigerant and returns it to the compressor. This device is not usually found on small equipment.

Oil trap	Mechanical device for returning oil entrained in the system; a low spot or sag in the refrigerant lines.
Open drive compressor	Compressor that is driven by an external motor. Some use belts and pulleys, others use shaft-to-shaft couplings.
Open circuit	Electrical circuit that has been interrupted to stop the flow of electricity. Open circuit testing is taking a voltage reading at the open location in the circuit. In low voltage and millivolt circuits the open circuit voltage will usually be higher than with a load imposed on the circuit.
Orifice	Precision opening in a device to control the amount of the substance through that opening.
Overload protector	Safety device which stops the motor when an excessive current flow occurs.
Package units	Self-contained unit that contains all necessary components to make up the unit. This does not include any duct work needed to distribute the air.
Pitot tube	Device used to measure air velocities, normally used in conjunction with a manometer.
Potential relay	Relay with normally closed contacts used to start an electric motor. Relay contacts open when pickup voltage is obtained (a higher voltage than applied to the motor) and closes when dropout voltage is reached (a lower voltage than the pickup voltage).
Printed circuit (PC) board	Electronic control board that controls one or more functions in the operation of the equipment in which it is used. Also see integrated furnace control (IFC).
Psychrometer	Instrument used to determine the relative humidity of air.
Reciprocating compressor	Compressor that uses pistons and valves to compress gas to a high pressure.
Refrigerant	Substance that absorbs heat as it vaporizes and gives up heat as it condenses.
Refrigerant filter	Device used for the removal of solid particles from the refrigerant.
Refrigerant filter drier	Device used for the removal of solid particles and moisture from the refrigerant.
Refrigeration	Process of removing heat.
Relay	Device that operates from one electric source to effect the operation of another electric source.

Reversing valve	Valve used to reverse flow of the refrigerant within the system.
Rotary compressor	Compressor that rotates a movable vane within a concentric housing to compress gas to a higher pressure.
Safety control	Any device that will stop the operation of a piece of equipment when the operation gets beyond the high limit settings of the system.
Schrader valve	Spring-loaded valve that allows gas or fluid to pass when the center pin is depressed, like a valve core on a tire.
Screw compressor	Compressor that has two mating revolving screws that compress gas to a higher pressure.
Scroll compressor	Compressor that has two scrolls designed to compress a vapor. The scroll compressor only has two moving parts. One of the scrolls is attached to the rotor of the motor and moves within the other scroll, which is free to move.
Semihermetic compressor	Compressor that can be taken apart to make repairs.
Sensible heat	Heat that causes a change in temperature and can be measured. Sensible heat does not cause a change of state.
Sensor	Device that detects a change in surrounding condition of the sensor.
Short circuit	Condition that occurs when part of an electrical circuit comes in contact with another part of the circuit or causes the current to take an improper path.
Sling psychrometer	Instrument with dry bulb and wet bulb thermometers that is moved rapidly through the air to obtain a relative humidity reading.
Split system	Refrigeration system whose condensing section is located apart from the evaporator section.
Subcooling	Cooling of the refrigerant below its liquid saturation temperature corresponding to its pressure.
Suction line	Line that carries the vaporized refrigerant back to the compressor from the evaporator. Also see vapor line.
Superheat	Amount of temperature increase above the saturated liquid temperature corresponding to its pressure.
Therm	Term used by the natural gas industry that represents 100,000 BTUs.
Thermistor	Semiconductor that changes electrical resistance as the temperature changes.

Thermocouple	Device that generates electricity when heat is applied to two dissimilar metals that are welded together; sensing device used with electronic instruments.
Thermometer	Instrument used to measure sensible heat.
Thermostat	Temperature-sensing control that responds to temperature changes to control the system.
Thermostatic expansion valve	Metering device in a refrigeration system that controls the amount of liquid refrigerant that enters the evaporator. This valve is controlled by both temperature and pressure. A thermostatic expansion valve will maintain a constant superheat.
Time delay relay	Relay that is actuated after a predetermined time from the point of impulse.
Transformer	Electrical device that transforms voltage from one level to another.
Two-temperature valve	Pressure-operated valve used with multiple evaporators in refrigeration installations so that evaporators can be at different temperatures.
Ultrasonic leak detector	Leak detector that picks up ultrasonic sound waves generated by leaking gas. Will also pick up ultrasonic sound waves generated by air being pulled into a system that is under a vacuum.
Ultraviolet leak detector	Leak detector that is used in conjunction with an ultraviolet light source and a dye that is sensitive to ultraviolet light.
Vacuum	Reduction in pressure below atmospheric pressure usually measured in inches of mercury or microns.
Vacuum pump	Pump used to remove air/moisture and other gases from the refrigeration system by lowering the boiling point of water.
Vapor line	Heat pump application term used to describe what is called the suction line in air conditioning and refrigeration applications. This line carries refrigerant in vapor form. The vapor may be hot or cold depending on mode of operation. In a heat pump the only true suction line is located between the reversing valve and the compressor. Therefore the interconnecting line is referred to as a vapor line. Also see suction line.
Voltmeter	Instrument used to measure voltage.
Volume damper	Device used to control the volume of air that flows within a main or branch duct.
Watt	Unit of electrical power.

Academic Skills	Skills (and related knowledge) contained in the subject areas and disciplines addressed in most national and state educational standards, including English, mathematics, science, etc.
Assessment	A process of measuring performance against a set of standards through examinations, practical tests, performance observations and/or the completion of work portfolios.
Content Standard	A specification of what someone should know or be able to do to successfully perform a work activity or demonstrate a skill.
Critical Work Functions	Distinct and economically meaningful sets of work activities critical to a work process or business unit which are performed to achieve a given work objective with work outputs that have definable performance criteria. A critical work function has three major components: • **Conditions of Performance:** The information, tools, equipment and other resources provided to a person for a work performance. • **Work to Be Performed:** A description of the work to be performed. • **Performance Criteria:** The criteria used to determine the required level of performance. These criteria could include product characteristics (e.g., accuracy levels, appearance), process or procedure requirements (e.g., safety, standard professional procedures) and time and resource requirements. The IOSSCC requires that these performance criteria be further specified by more detailed individual performance elements and assessment criteria.
Credentialing	The provision of a certificate or award to an individual indicating the attainment of a designated set of knowledge and skills and/or the demonstration of a set of critical work functions for an industry/occupational area.
Illinois Occupational Skill Standards and Credentialing Council (IOSSCC)	Legislated body representing business and industry which establishes skill standards criteria, endorses final products approved by the industry subcouncil and standards development committee and assists in marketing and dissemination of occupational skill standards.
Industry	Type of economic activity, or product or service produced or provided in a physical location (employer establishment). They are usually defined in terms of the Standard Industrial Classification (SIC) system.

Industry Subcouncil	Representatives from business/industry and education responsible for identifying and prioritizing occupations for which occupational performance skill standards are adapted, adopted or developed. They establish standards development committees and submit developed skill standards to the IOSSCC for endorsement. They design marketing plans and promote endorsed skill standards across the industry.
Knowledge	Understanding the facts, principles, processes, methods and techniques related to a particular subject area, occupation or industry.
Occupation	A group or cluster of jobs, sharing a common set of work functions and tasks, work products/services and/or worker characteristics. Occupations are generally defined in terms of a national classification system including the Standard Occupational Classification (SOC), Occupational Employment Statistics (OES) and the Dictionary of Occupational Titles (DOT).
Occupational Cluster	Grouping of occupations from one or more industries that share common skill requirements.
Occupational Skill Standards	Specifications of content and performance standards for critical work functions or activities and the underlying academic, workplace and occupational knowledge and skills needed for an occupation or an industry/occupational area.
Occupational Skills	Technical skills (and related knowledge) required to perform the work functions and activities within an occupation.
Par Levels	Par refers to a specific quantity of items kept in stock to ensure efficient operation. Par levels are set by property and/or corporate management based on calculations of past usage and projected occupancy.
Performance Standard	A specification of the criteria used to judge the successful performance of a work activity or the demonstration of a skill.
Product Developer	Individual contracted to work with the standard development committee, state liaison, industry subcouncil and IOSSCC for the adaptation, adoption or development of skill standards content.
Reliability	The degree of precision or error in an assessment system so repeated measurements yield consistent results.

Skill	A combination of perceptual, motor, manual, intellectual and social abilities used to perform a work activity.
Skill Standard	Statement that specifies the knowledge and competencies required to perform successfully in the workplace.
Standards Development Committee	Incumbent workers, supervisors and human resource persons within the industry who perform the skills for which standards are being developed. Secondary and postsecondary educators are also represented on the committee. They identify and verify occupational skill standards and assessment mechanisms and recommend products to the industry subcouncil for approval.
State Liaison	Individual responsible for communicating information among all parties (e.g., IOSSCC, subcouncil, standard development committee, product developer, project director, etc.) in skill standard development.
Third-Party Assessment	An assessment system in which an industry-designated organization (other than the training provider) administers and controls the assessment process to ensure objectivity and consistency. The training provider could be directly involved in the assessment process under the direction and control of a third-party organization.
Validity	The degree of correspondence between performance in the assessment system and job performance.
Workplace Skills	The generic skills essential to seeking, obtaining, keeping and advancing in any job. These skills are related to the performance of critical work functions across a wide variety of industries and occupations including problem solving, leadership, teamwork, etc.

Sam Anderson	Vice President American Postal Workers' Union
Colleen Bueche	Human Resources Supervisor Enterprise Rent-A-Car
John Burner	Assistant State Director United Transportation Union
Elwood Flowers	Lobbyist Amalgamated Transit
Carl Gallman	Administrative Assistant International Association of Machinists.
Karl Gnadt	Assistant to the Managing Director Champaign/Urbana Mass Transit District
Donald Good	Manager, Transportation Network U.S. Postal Service, Chicago Central P&DC
Wayne Grieder	President Archer Kostner Automotive
Thomas Nicely	Logistic Specialist JKC Trucking Company
Bruce Peterson	Mail Transport Equipment Coordinator U.S. Postal Service, Chicago Central P&DC
David Regner	Illinois School Transportation Association
Roger Roberson	CEO PFT/Roberson Corporation
Dianna Rushing	Association of Flight Attendant's Council
Carolyn Schoeneman	Manager Ground Employment ORDEX- United Airlines
Andy Sievers	Vice-President of Safety and Organizational Development PFT/Roberson Corporation

Joseph Szabo	State Director United Transportation Union
Paul Tatman	President Tatman Auto Body, Inc.
Russ Verona	President East Rockford Collision Center-North
Michael Wagner	General Manager Alpha Special Services
Vince Waters	Illinois Chapter of the American Concrete Pavement Association
Russ Wittkop	Special Representative, Midwest Territory International Association of Machinists
Gerald Zero	Secretary/Treasurer Illinois AFL-CIO Teamsters' Union
Ron Engstrom	State Liaison Illinois State Board of Education

APPENDIX D

HVAC/R TECHNICIAN CLUSTER STANDARDS DEVELOPMENT COMMITTEE

Bob Baker	RESE-Isaacs Refrigeration Heating & Air Conditioning Springfield, IL
George Barron	Technical Service Manager Goodman Air Conditioning & Heating Belleville, IL
Michael Bishop	Service Manager York International Elmhurst, IL
Jim Craig	Environmental Control Systems/HVAC/R Elgin Community College Elgin, IL
Terry Davis	Director of HVAC/R Program Vatterott College Loraine, IL
Britt Ewalt	Vice President and Service Manager Standard Heating and Cooling Peoria, IL
Lani Greenway	Program Coordinator, REACT (HVAC/R) Illinois Central College East Peoria, IL
Herb Haushahn	Professor College of DuPage Glen Ellyn, IL
Kevin Miller	Service Manager Yeomans Distributing Company Peoria, IL
Mark Miller	President Allied Plumbing and Heating Springfield, IL
Scott Remington	Service Technician Johnson Controls Gifford, IL
Dean Larimore	Product Developer Retired HVAC/R Instructor Illinois Central College
Ron Engstrom	State Liaison Illinois State Board of Education

A. Developing an Employment Plan	1. Match interests to employment area. 2. Match aptitudes to employment area. 3. Identify short-term work goals. 4. Match attitudes to job area. 5. Match personality type to job area. 6. Match physical capabilities to job area. 7. Identify career information from counseling sources. 8. Demonstrate a drug-free status.
B. Seeking and Applying for Employment Opportunities	1. Locate employment opportunities. 2. Identify job requirements. 3. Locate resources for finding employment. 4. Prepare a resume. 5. Prepare for job interview. 6. Identify conditions for employment. 7. Evaluate job opportunities. 8. Identify steps in applying for a job. 9. Write job application letter. 10. Write interview follow-up letter. 11. Complete job application form. 12. Identify attire for job interview.
C. Accepting Employment	1. Apply for social security number. 2. Complete state and federal tax forms. 3. Accept or reject employment offer. 4. Complete employee's Withholding Allowance Certificate Form W-4.
D. Communicating on the Job	1. Communicate orally with others. 2. Use telephone etiquette. 3. Interpret the use of body language. 4. Prepare written communication. 5. Follow written directions. 6. Ask questions about tasks.
E. Interpreting the Economics of Work	1. Identify the role of business in the economic system. 2. Describe responsibilities of employee. 3. Describe responsibilities of employer or management. 4. Investigate opportunities and options for business ownership. 5. Assess entrepreneurship skills.
F. Maintaining Professionalism	1. Participate in employment orientation. 2. Assess business image, products and/or services. 3. Identify positive behavior. 4. Identify company dress and appearance standards. 5. Participate in meetings in a positive and constructive manner. 6. Identify work-related terminology. 7. Identify how to treat people with respect.

G. Adapting to and Coping with Change	1. Identify elements of job transition. 2. Formulate a transition plan. 3. Identify implementation procedures for a transition plan. 4. Evaluate the transition plan. 5. Exhibit ability to handle stress. 6. Recognize need to change or quit a job. 7. Write a letter of resignation.
H. Solving Problems and Critical Thinking	1. Identify the problem. 2. Clarify purposes and goals. 3. Identify solutions to a problem and their impact. 4. Employ reasoning skills. 5. Evaluate options. 6. Set priorities. 7. Select and implement a solution to a problem. 8. Evaluate results of implemented option. 9. Organize workloads. 10. Assess employer and employee responsibility in solving a problem.
I. Maintaining a Safe and Healthy Work Environment	1. Identify safety and health rules/procedures. 2. Demonstrate the knowledge of equipment in the workplace. 3. Identify conservation and environmental practices and policies. 4. Act during emergencies. 5. Maintain work area. 6. Identify hazardous substances in the workplace.
J. Demonstrating Work Ethics and Behavior	1. Identify established rules, regulations and policies. 2. Practice cost effectiveness. 3. Practice time management. 4. Assume responsibility for decisions and actions. 5. Exhibit pride. 6. Display initiative. 7. Display assertiveness. 8. Demonstrate a willingness to learn. 9. Identify the value of maintaining regular attendance. 10. Apply ethical reasoning.
K. Demonstrating Technological Literacy	1. Demonstrate basic keyboarding skills. 2. Demonstrate basic knowledge of computing. 3. Recognize impact of technological changes on tasks and people.
L. Maintaining Interpersonal Relationships	1. Value individual diversity. 2. Respond to praise or criticism. 3. Provide constructive praise or criticism. 4. Channel and control emotional reactions. 5. Resolve conflicts. 6. Display a positive attitude. 7. Identify and react to sexual intimidation/harassment.
M. Demonstrating Teamwork	1. Identify style of leadership used in teamwork. 2. Match team member skills and group activity. 3. Work with team members. 4. Complete a team task. 5. Evaluate outcomes.

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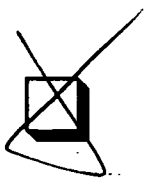

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